A McGRAW-HILL PUBLICATION **AUGUST 1961**

ONE DOLLAR

Power

the magazine of energy systems engineering

Who cares about industrial protective relaying?.. 63

Piping ideas for circulating-oil lube systems..... 91

Deep-well disposal for troublesome wastes..... 94

News briefs on latest nuclear developments..... 98

Maximum working pressure for alloy-steel pipe.... 100

Why vapor-cooling cycles take many forms..... 138

Marmaduke Surfaceblow's wet paper..... 148

How written instructions aid PM at Boeing..... 177

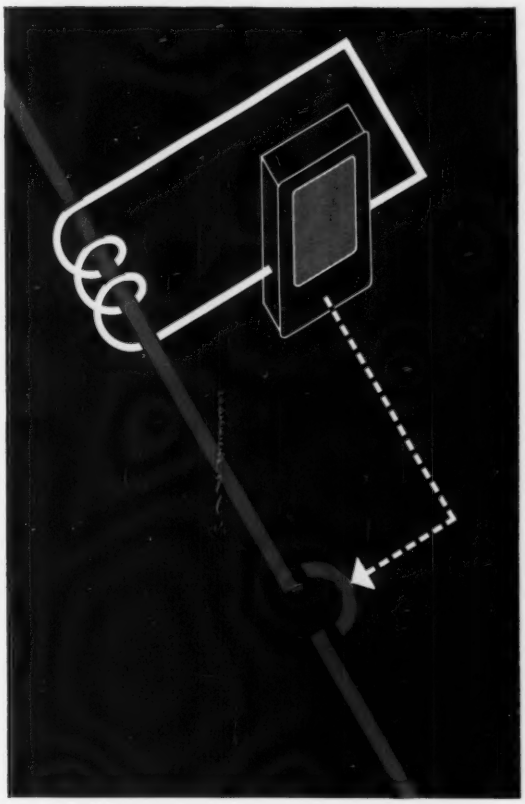
One way to stop steam-pressure fluctuations..... 180

Potential explosions can be nipped in the bud.... 182

Reaching for optimum ion-exchange regeneration? 184

N. Y. C. blackout spotlights emergency-power need 186

This trailer-mounted diesel puts out 300 kw..... 195

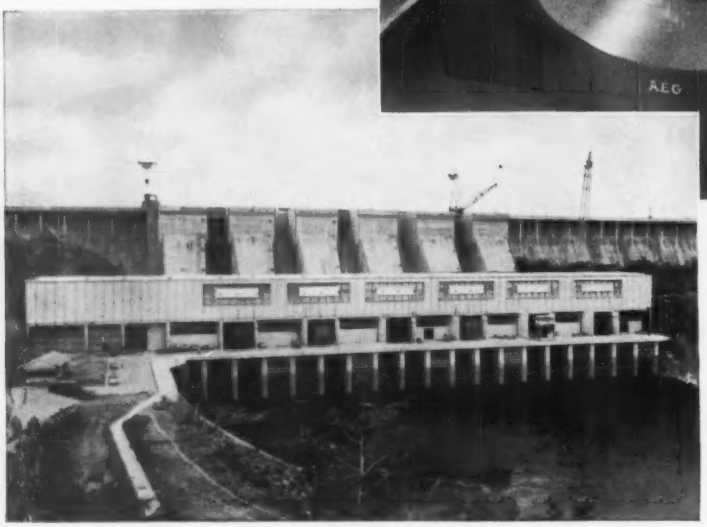


Protective Relaying

a 24-p special report • 67

One of the most important hydro-electric power stations

An interior view of the Caroní-Macagua machine hall



Caroní-Macagua dam and power station viewed from tailrace

One of the most important hydro-electric power stations is now under construction on the lower reaches of the Rio Caroní in Venezuela.

AEG

With its six 70 MVA, 116 rev/min AEG umbrella-type alternators it will furnish power for a vital industrial centre being developed in an area rich in resources.

8917 e

ALLGEMEINE ELEKTRICITÄTS-GESELLSCHAFT

Berlin (West) EXPORT DEPARTMENT Frankfurt (Main)

For more facts circle 201 on Reader Service card, p 107

Shave thermal insulation costs with "K&M" Zebra*

***A low, medium, and high temperature multi-layer, sectional-type pipe insulation, of calcium-silicate-asbestos bonded felts, for temperatures ranging from 200 F to 1200 F.**

1

Lower labor costs of installation. "K&M" ZEBRA Pipe Insulation, made in half-sections thru 24" pipe size, goes on fast. Reduces number of joints. Its smooth, practically dust-free surface won't penetrate skin, or cause irritations.

2

Reduced breakage and wastage costs during installation. "K&M" ZEBRA Pipe Insulation has a deflection at breaking point 2 to 4 times that of ordinary thermal insulation. It's easy to cut and fit on the job. Saves on material costs.

3

Minimum interruption to your production schedule. Your production goes back to normal faster . . . with the swift, efficient installation of "K&M" ZEBRA Pipe Insulation. Delays and downtime are minimum. Production costs go down.

4

Little or no upkeep costs. "K&M" ZEBRA Pipe Insulation requires no coddling on the job. Won't crack or warp from shock or heat. Withstands intense vibration without cracking or abrading. Its service life is almost maintenance-free.

5

Maximum re-usability. You can dismantle, re-apply, and re-use "K&M" ZEBRA Pipe Insulation on other applications. Thus, you can save on the costs of new thermal insulating materials . . . profit from longer service of "K&M" ZEBRA.

"K&M" ZEBRA® Pipe Insulation aids you in the fight against the cost-price squeeze and downward-spiraling profit margins. "K&M" offers you a complete line of quality asbestos insulations . . . blocks, spray-type materials, and cements . . . plus high-grade asbestos textiles.

For more information, write to: Keasbey & Mattison Company, Ambler, Pa., Dept. I-181. In Canada, write to: Atlas Asbestos Company, Limited, 5600 Hochelaga Street, Montreal 5, P.Q.

For more facts circle 204 on Reader Service card, p 107

speaking of **Power**

COLE AND O'CONNOR at Federal Pacific conference

The press conference is a proved practical device used by equipment manufacturers to announce a significant product development, a challenging research area being explored, or perhaps a reorientation of company aims. Seasoned editors and reporters use such a gathering as a convenient place to step beyond the immediate purpose and search out management's thinking on a host of kindred subjects: economics, limiting technical horizons, labor, to name a few.

One recent conference called by Federal Pacific Electric brought out their young and exceptionally keen president, T M Cole. Prior to the formal press conference, POWER's Managing Editor Jim O'Connor sampled Tom Cole's thinking on the future of static relaying (excellent, but still in the early stages), immediate prospects for current-limiting fuses (good, and getting better), applications for plastic-insulated low-impedance busway with "give" in the insulated mounts (well suited to vertical risers), economics of fused load-break equipment in the 600-volt class (hard to beat).

What was announced at this Federal Pacific press conference? A line of power circuit breakers with Power-to-Grow . . . *electrically* features—see p 122.

Lou Rowley

L N ROWLEY — Publisher

B G A SKROTZKI — Design and Application
S M ELONKA — Maintenance and Management
J J O'CONNOR — Managing Editor
T W EDWARDS — Associate Editor
R H MARKS — Associate Editor
N PEACH — Associate Editor
P SCHWABE — Assistant Editor
C F MARSCHALEK — Art Editor

DOMESTIC NEWS BUREAU: Atlanta, Chicago, Cleveland, Dallas, Detroit, Los Angeles, San Francisco, Seattle, Washington, D. C.
WORLD NEWS OFFICES: Beirut, Bonn, Caracas, London, Mexico City, Moscow, Paris, Tokyo, Rio de Janeiro

CLARK BOUGHTON — Sales Manager

DISTRICT MANAGERS

ATLANTA 9, GA. – R K Burnet, 1375 Peachtree Street, NE, Trinity 5-0523 (Area Code 875)
BOSTON 16, MASS. – D L Kates, McGraw-Hill Building, Copley Square, Congress 2-1160
CHICAGO 11, ILL. – L W Romigh and T W McClure Jr, 645 North Michigan Avenue, Mohawk 4-5800
CLEVELAND 13, OHIO – R E Heisserman, 55 Public Square, Superior 1-7000
DALLAS 1, TEXAS – F E LeBeau, 901 Vaughn Building, 1712 Commerce Street, Riverside 7-9721
DENVER 2, COLO. – J W Patten, Tower Building, 1700 Broadway, Alpine 5-2981
DETROIT 26, MICH. – L W Romigh, 856 Penobscot Building, Woodward 2-1793
HOUSTON 25, TEXAS – D O Hanson, W-724 Prudential Building, Holcombe Blvd, Jackson 6-1281
LOS ANGELES 17, CALIF. – N C Humphrey, 1125 West Sixth Street, Huntley 2-5450
NEW YORK 36, N. Y. – G W Simpson and D L Kates, 500 Fifth Avenue, Oxford 5-5959
PHILADELPHIA 3, PA. – C R Long, Six Penn Center Plaza, Locust 8-4330
PITTSBURGH 22, PA. – R E Heisserman, 4 Gateway Center, Express 1-1314
ST. LOUIS 8, MO. – T W McClure Jr, Continental Building, 3615 Olive Street, Jefferson 5-4867
SAN FRANCISCO 11, CALIF. – J J Hernan, 255 California Street, Douglas 2-4600
LONDON W1, ENGLAND – E E Schirmer, McGraw-Hill Publishing Co, Ltd, 34 Dover Street
FRANKFURT-MAIN, GERMANY – S Kimes, McGraw-Hill Publishing Co, Inc, 85, Westendstrasse
GENEVA, SWITZERLAND – M R Zeynel, McGraw-Hill Publishing Co, Inc, 2, Place du Port

Print order this issue: 50,054

POWER (with which are consolidated *Science and Industry, The Engineer Review, The Engineer, The Stationary Engineer* and *Operating Engineer*) is published monthly by McGraw-Hill Publishing Company, Inc, James H McGraw (1860-1948), Founder. PUBLICATION OFFICE: McGRAW-HILL BUILDING, 330 W 42nd St, New York 36, N. Y. See box, right, for directions regarding subscriptions or change of address. EXECUTIVE, EDITORIAL, CIRCULATION and ADVERTISING OFFICES: 330 W 42nd St, New York 36, N. Y. OFFICERS OF THE PUBLICATIONS DIVISION: Nelson L Bond, President; Shelton Fisher, Wallace F Traendly, Senior Vice-Presidents; John R Callaham, Vice-President and Editorial Director; Joseph H Allen, Vice-President and Director of Advertising Sales; A R Venezian, Vice-President and Circulation Coordinator. OFFICERS OF THE CORPORATION: Donald C McGraw, President; Joseph A Gerardi, Hugh J Kelly, Harry L Waddell, Executive Vice-Presidents; L Keith Goodrich, Vice-President and Treasurer; John J Cooke, Secretary.

Subscriptions are solicited only from executives, engineers and supervisory personnel engaged in design, operation and maintenance of the power and plant services in utilities, consulting and contracting firms, industrial and service plants. Position and company connection must be indicated on subscription orders. Send to address shown in box, right.

United States subscription rate for individuals in the field of the publication $3.00 per year, single copies $1.00, unless otherwise indicated. Canada; $5.00 for one year. Foreign; $15.00 for one year. Second-class

In Power this month

AUGUST 1961 • VOL. 105 • NO. 8 • 79TH YEAR

Editorial: Who cares about industrial relaying? ____ 63

DESIGN AND EQUIPMENT APPLICATION

PROTECTIVE RELAYING: A 24-p special report ____ 67
How relaying of industrial protection zones is planned on a system basis. . . . Principles underlying relay action: induction, electromagnetic, solid-state. . . . Important role of instrument transformers. . . . What you must know before selecting relay types. . . . Steps in coordinating protective devices. . . . The elements of a sound maintenance program

Piping for circulating-oil lube systems—part 3 ____ 91

Check on deep-well disposal for specially troublesome wastes ____ 94

DEPARTMENTS

Nuclear notes: News briefs on the latest developments ____ 98

Data sheet: Maximum allowable working pressure for alloy-steel pipe—part 3 ____ 100

Technical briefs: A world-wide look at progress in energy-systems engineering ____ 102

New literature: Yours simply for mailing postage-free Reader Service card ____ 107

Plant equipment news: Information center for new products and materials ____ 122

Thermo refresher: Vapor-cooling cycles take many forms ____ 138

Marmaduke Surfaceblow's wet paper ____ 148

Powerscope: A selective look at this month's power-field happenings ____ 160

Calendar of events ____ 166 *Appointments* ____ 170 *Bookshelf* ____ 174

PLANT MAINTENANCE AND MANAGEMENT

Clearly written instructions key preventive maintenance at Boeing ____ 177

We stopped steam-pressure fluctuations ____ 180

Operators' notebook: Nip dangerous explosions in the bud ____ 182

Boost plant efficiency by optimum ion-exchange regeneration ____ 184

New York City blackout spotlights need for emergency power ____ 186

Plant problems: Here's how *Power* readers tackle them ____ 188

Practical ideas to keep your plant running at peak efficiency ____ 192

Trailer-mounted diesel generator supplies 300 kw of power where you need it ____ 195

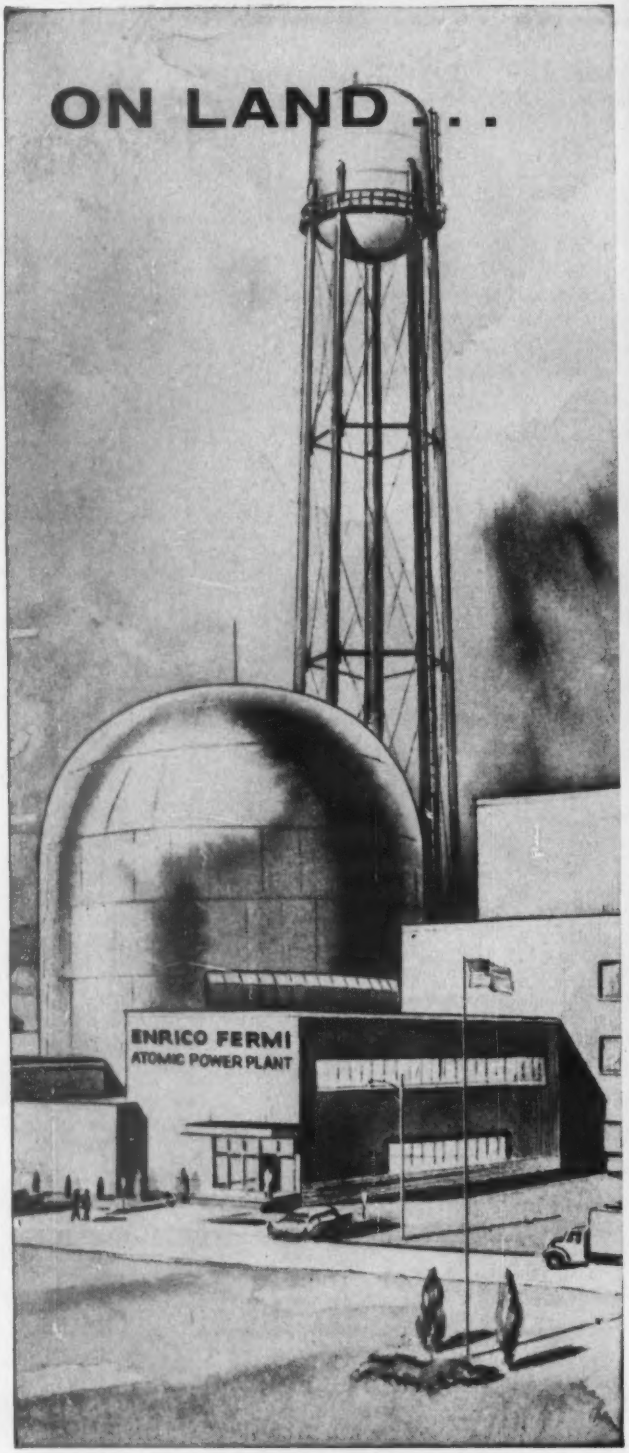
postage paid at New York, N. Y. and additional mailing offices. Printed in U.S.A. Title registered in U.S. Patent Office. © Copyright 1961 by McGraw-Hill Publishing Company, Inc. All rights reserved.

UNCONDITIONAL GUARANTEE: Our primary aim is to provide subscribers with a useful and valuable publication. Your comments and suggestions for improvement are encouraged and will be most welcome. The publisher, upon written request from any subscriber to our New York office, agrees to refund the part of the subscription price applying to copies not yet mailed.

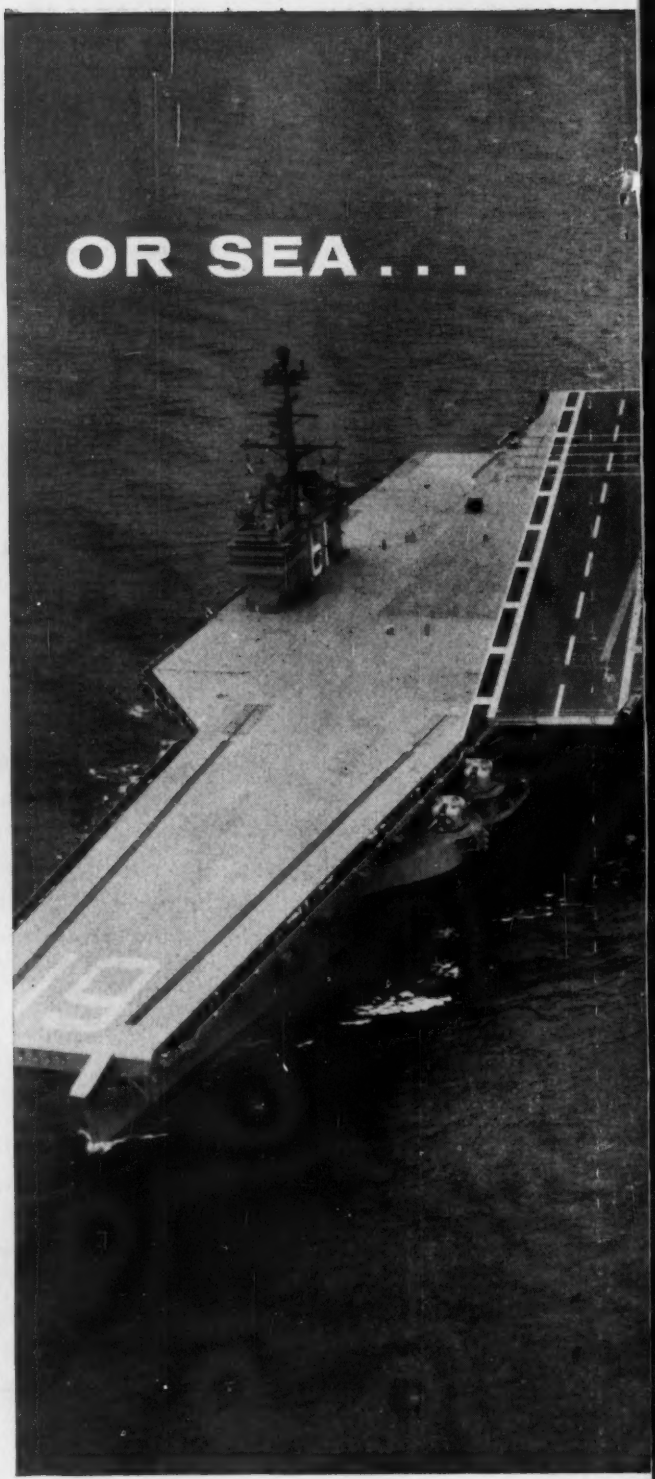
Power articles are indexed in both the *Industrial Arts Index* and the *Engineering Index*. POWER publishes its own annual index, obtainable on request to the Editor. Notice of availability appears in POWER.

SUBSCRIBERS: Send subscription correspondence and change of address to Fulfillment Manager, POWER, 330 W 42nd St, New York 36, N. Y. Subscribers should notify Fulfillment Manager promptly of any change of address, giving old as well as new address, and including postal zone number, if any (Official Post Office request). If possible, enclose an address label from a recent issue of the magazine. Since copies are addressed one to two issues in advance, please allow one month for change of address to become effective.

Postmaster: Send form 3579 to POWER, 330 W 42nd St, N. Y. 36, N. Y.



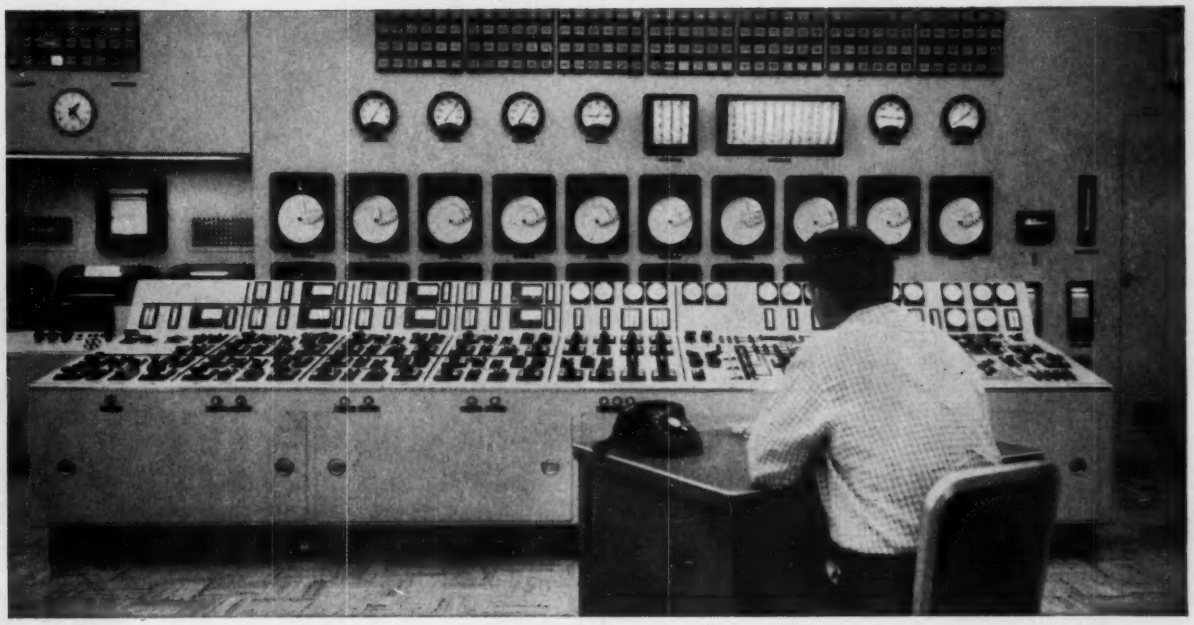
At the Enrico Fermi Atomic Power Plant, instruments and controls for both the "fast neutron breeder" reactor and the steam plant which it will "fire" are being furnished by Bailey.



Many of the new ships such as this super-carrier, USS Ranger, operate their boilers by Bailey Meter Control. Cargo ships, tankers, and passenger liners as well as Naval ships improve the economy and safety of their steam plants thru use of Bailey controls.

At the Thomas H. Allen Electric Generating Station of the City of Memphis, Tenn., Bailey operating indicators and controls for combustion, feed water, and steam temperature are centralized on the mechanical bench-board directly ahead, while the operating records which reflect trends are mounted on the vertical boards. A Bailey METROTYPE Information System, center left in the photo, scans, monitors, and logs functions usually assigned to strip-chart recorders.

IT'S BAILEY. . .



for the latest and safest instruments and controls for nuclear and conventional power plants!

Many of the power plants of the future will have controls and instruments designed and built by Bailey. There are two reasons: Bailey's continuing research and development toward the latest equipment for industry's needs; Bailey's 40-year association with the hardware and economic requirements of the industry.

If you are planning new or improved power plant facilities, call on Bailey engineers to assure that your system will have the *proper balance both as to economics and needs . . . that there will not be the unnecessary expense of over-instrumentation or control . . . nor the duplication of equipment functions.*

Call on Bailey for primary sensing devices, indicators, loggers, control units, panels, data handling equipment, computers for performance analysis, and supervisory controls. You'll find designs ranging from conventional to the most sophisticated . . . mechanical, pneumatic, electric and electronic, including solid state.

There's a Bailey District Office or Resident Engineer close to you. Check your phone book, or write direct.

A144-2

Instruments and controls for power and process

BAILEY METER COMPANY

1036 IVANHOE ROAD • CLEVELAND 10, OHIO

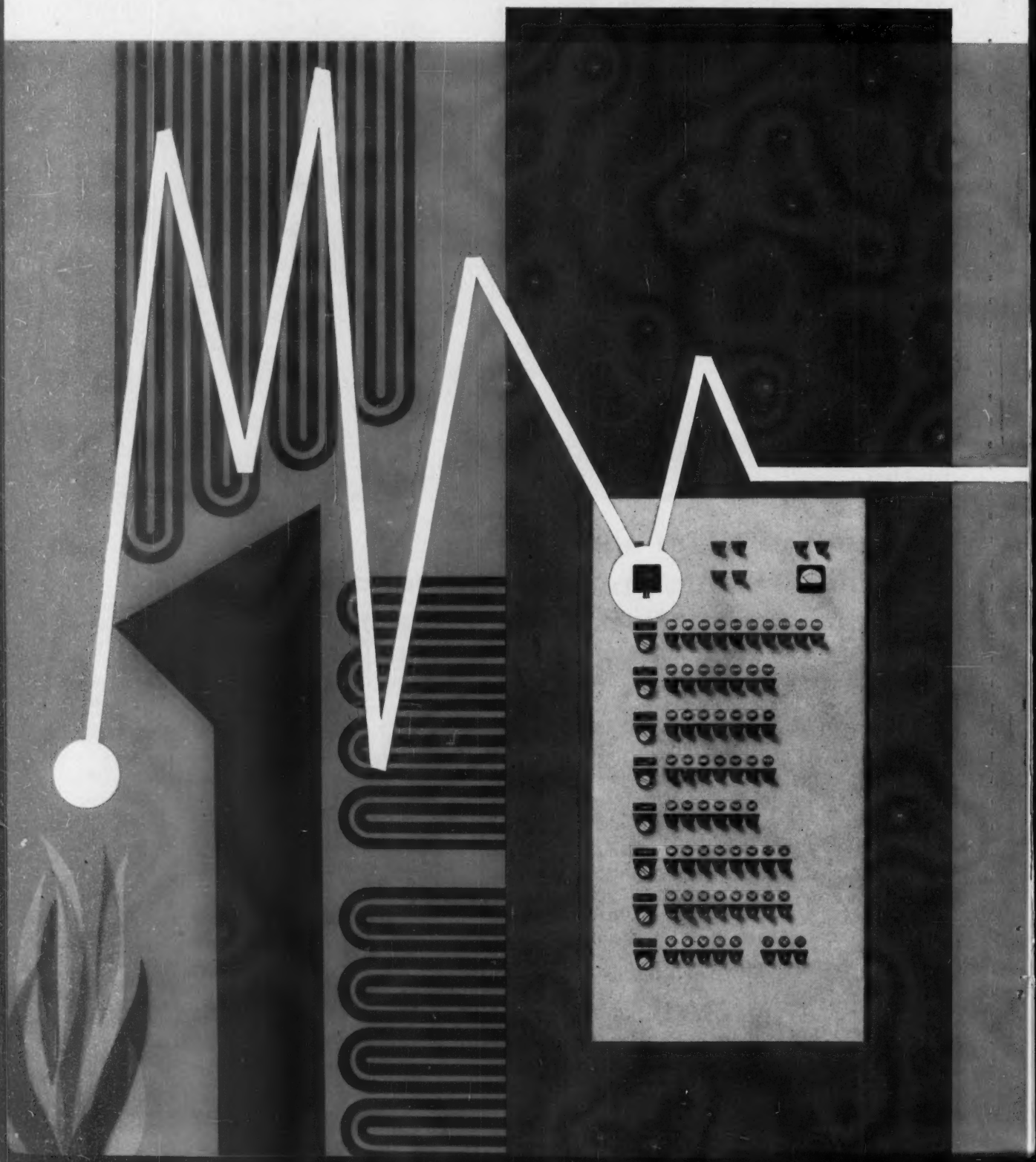
In Canada—Bailey Meter Company Limited, Montreal

For more facts circle 205 on Reader Service card, p 107

Circle 206 on Reader Service card for following ad ➤

Diamond developed for more economical power

MONITORMATIC...NEW SELF-CONTROL FOR MORE EFFICIENT BOILER CLEANING



Optimum frequency of blower cycling is assured with Monitormatic . . . Diamond's completely automatic boiler cleaning system.

Monitormatic is an automatic method of maintaining constant furnace cleanliness and heat absorption. It responds automatically to changing boiler conditions and eliminates indiscriminate, unnecessary or insufficient blowing. Savings are realized through optimum use of blowing medium, minimized soot blower maintenance, less compressor maintenance if air is used as blowing medium, and reduced operator time. It also automatically adjusts the cleaning system to fuel changes.

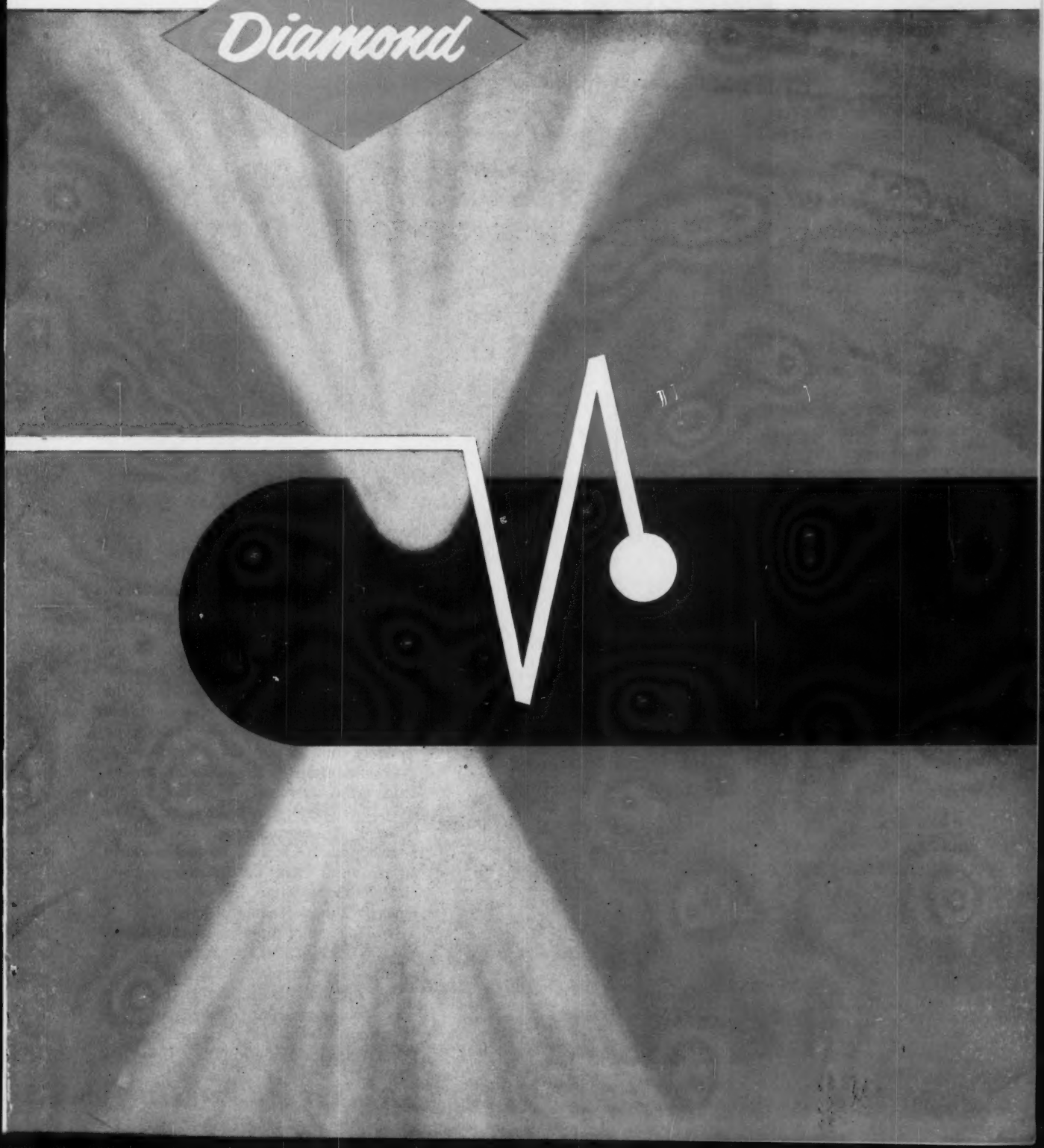
Monitormatic is readily and economically applicable to new or many existing Diamond Selectromatic Systems; is another example of why "Diamond Developed" means more economical power generation.

At your request, our Engineers will be pleased to evaluate the application of Monitormatic to your specific system. Call, write or wire for complete information.

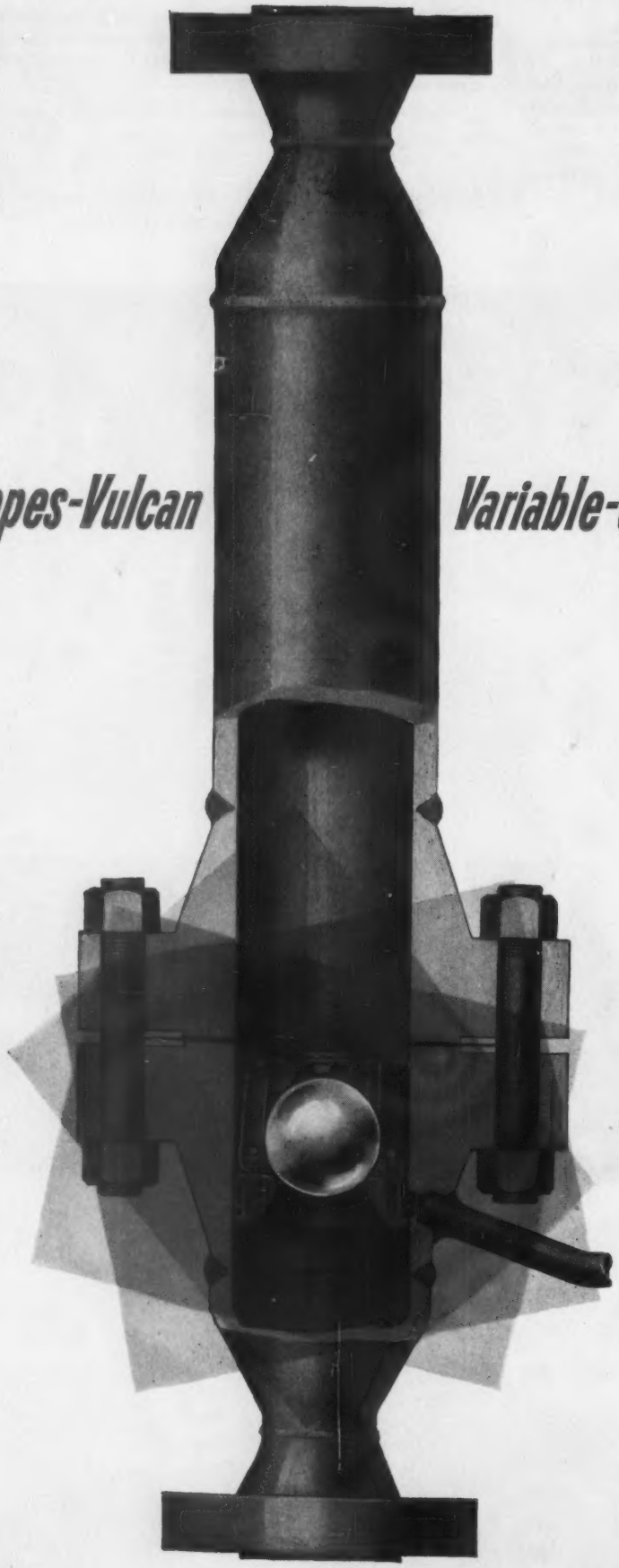
DIAMOND POWER SPECIALTY CORPORATION, Lancaster, Ohio

DIAMOND SPECIALTY LIMITED, Windsor, Ontario

Diamond



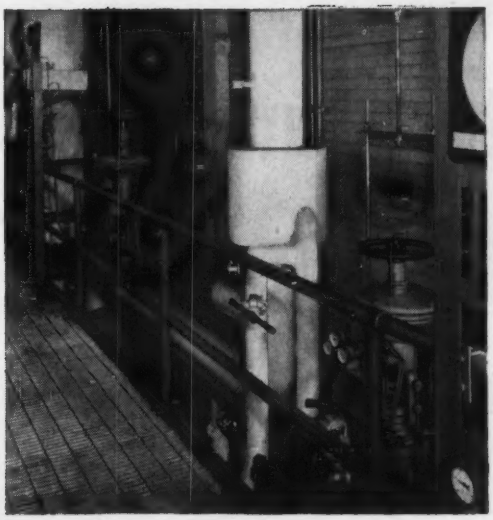
Copes-Vulcan Variable-Orifice desuperheater



This ball makes the difference. Steam pressure lifts a weighted steel ball off its ring seat to a position where it is balanced by steam pressure and flow through the orifice. The ball is held concentric by Inconel springs and rigid guides. This is the only moving part in the Copes-Vulcan Variable-Orifice desuperheater that so effectively controls steam temperature.

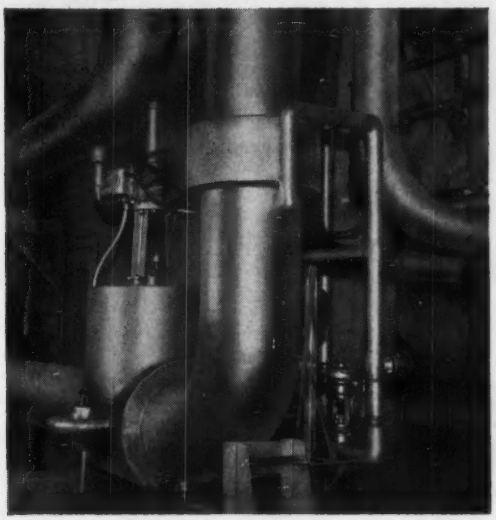
Cooling water enters through an annular orifice surrounding the ring seat at the point of maximum steam velocity. The passage of steam through the annular restriction between ball and seat produces an aspirating effect on the cooling water and entrains it in an area of high turbulence over the full range of flow.

No long run of piping is needed to mix the two fluids. There is no excess water to remove. No atomizing steam is used. There are no glands, stuffing boxes or spray nozzles. Pressure drop remains constant for all flows, and is normally 3 to 4 psig. Write for Bulletin 1037.



The problem: to maintain the temperature of residual fuel oil at 335°-380°F using station steam at 1250 psig and 950°F. Because of the high temperature heating requirements of the fuel, it was necessary to use the station steam supply. To handle this tough assignment a single, combination pressure-reducing and regulating valve, Copes-Vulcan Type CV-D, followed by the Copes-Vulcan Variable-Orifice desuperheater was used. The cooling-water valve is also a Type CV-D. The desuperheater provides steam at the right temperature to control the fuel oil temperature and viscosity exactly. It has been in service over two years with no downtime and no operating problems.

solves knotty problems at two generating plants



The problem: to deliver 420°F steam at from 20,000 to 300,000 pounds per hour and within ± 5°F of the set point. Conventional desuperheating equipment could not be used because of the low superheat (30°F) and low flow conditions. A 12-inch, 300-psig standard Copes-Vulcan Variable-Orifice desuperheater, with outlet expanded to 20-inch pipe size, was the answer. The inlet is connected with the main steam-distribution header carrying steam at 220 psig and 500°F. The cooling-water supply is at 450 psig and 200°F. The specified pressure range is 425 to 475 psig. Cooling-water flow is automatically regulated by a Copes-Vulcan Type CV-D valve operated by a temperature controller in the steam heating supply line. Flow requirements at discharge temperature within ± 5°F have been met consistently though inlet temperatures vary from 520°F to 550°F.

Copes-Vulcan desuperheaters are designed for precise control of reduced steam temperatures under the most difficult operating conditions.

In addition to the Variable-Orifice, two other types are available. *The Carburetor-Type desuperheater* injects cooling water into the system with a spray nozzle. Available in standard 2-inch through 12-inch sizes in 150- through 600-pound pressure standard for cast steel. Larger sizes and higher pressure standards are available on special application. Write for Bulletin 1056.

Steam-Assist desuperheater has negligible permanent pressure loss on loads of 15% to 100% of maximum. This in-line desuperheater normally uses assisting steam only on light loads where control is most difficult. Write for Bulletin 1024-A. Copes-Vulcan Division, Erie 4, Pennsylvania.

Copes-Vulcan Division

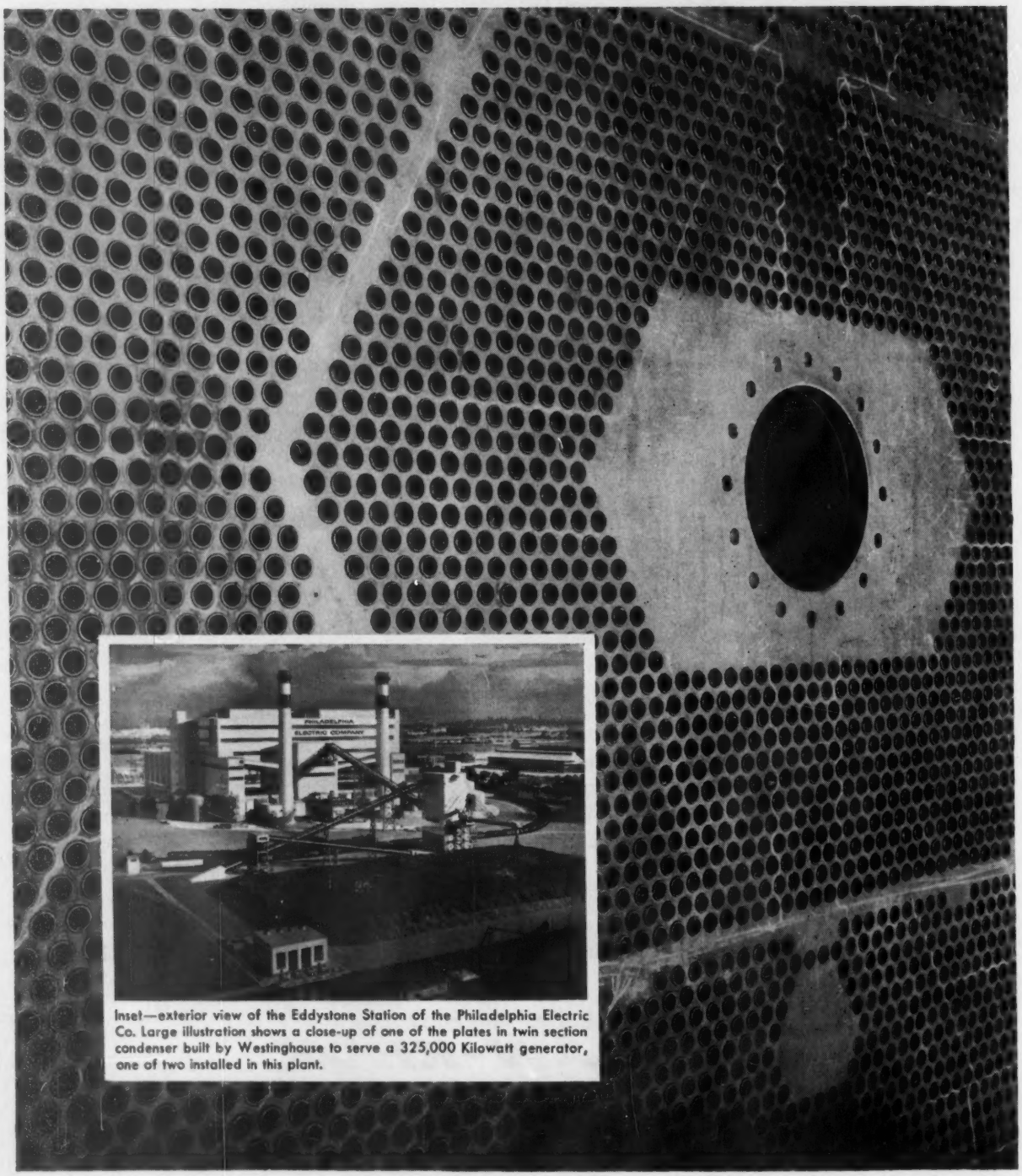
BLAW-KNOX

BLAW-KNOX

Blaw-Knox designs and manufactures for America's growth industries: METALS: Rolling Mills • Steel Processing Lines • Rolls • Castings • Open Hearth Specialties • PROCESSING: Process Design, Engineering and Plant Construction Services • Process Equipment and Pressure Piping • CONSTRUCTION: Concrete and Bituminous Paving Machines • Concrete Batching Plants and Forms • Gratings • AEROSPACE: Fixed and Steerable Antennas • Radio Telescopes • Towers and Special Structures • POWER: Power Plant Specialties and Valves

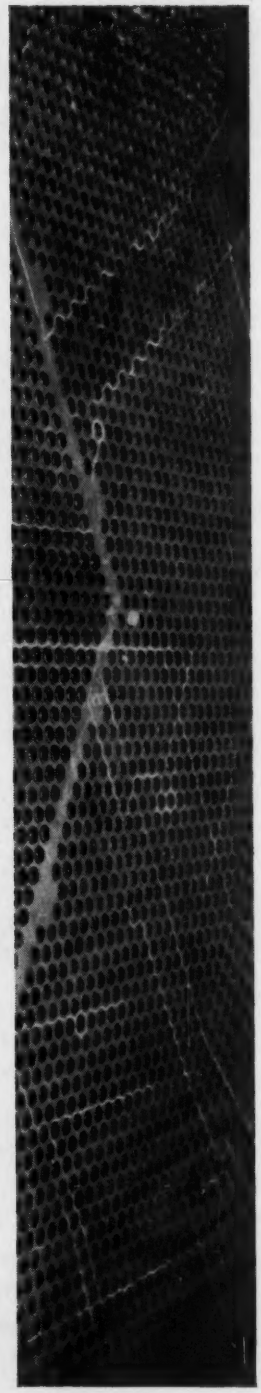
For more facts circle 207 on Reader Service card, p 107

New Temperature and Pressure Generator—Using 162 Tons



Inset—exterior view of the Eddystone Station of the Philadelphia Electric Co. Large illustration shows a close-up of one of the plates in twin section condenser built by Westinghouse to serve a 325,000 Kilowatt generator, one of two installed in this plant.

Records Set by Steam Turbine of Revere Condenser Tubes



Westinghouse-Built Twin Section Condenser Installed at Eddystone Station of the Philadelphia Electric Co.

No. 1 steam turbine-generator in the new Eddystone Station of the Philadelphia Electric Company is setting new records for pressure and temperature with initial steam throttle conditions of 5000 psi and 1200°F.

Helping to assure this efficiency is a 150,000 sq. ft. surface condenser . . . equipped with over 162 tons of Revere Tubes. In the main condenser area, 23,075 Revere Admiralty Tubes—¾″ O.D. x 18 BWG x 30′ long are used. Because of ammonia in the exhaust steam, the air cooling section uses Admiralty Bi-Metal Tubes. In this section of the Westinghouse Surface Unit, 2,745 tubes are installed, Type 316 welded stainless steel, .024″ wall, drawn over Admiralty with an .025″ wall.

Here at Eddystone, as in so many generating plants, varying operating conditions call for specific types of tubes best-suited to meet the specific conditions. Revere, with its wide experience in these matters, was called upon to recommend the proper type of tubes.

This same wide choice of materials and construction, combined with unequalled experience, makes Revere your best source of tubes for original equipment or replacement. Why not put this knowledge and the Industry's widest line of tube materials and types to work before you make the final selection of tubes and plates for your equipment? You can bring them to bear on your problems by calling the nearest Revere Sales Office.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

Executive Offices: 230 Park Avenue, New York 17, N. Y.

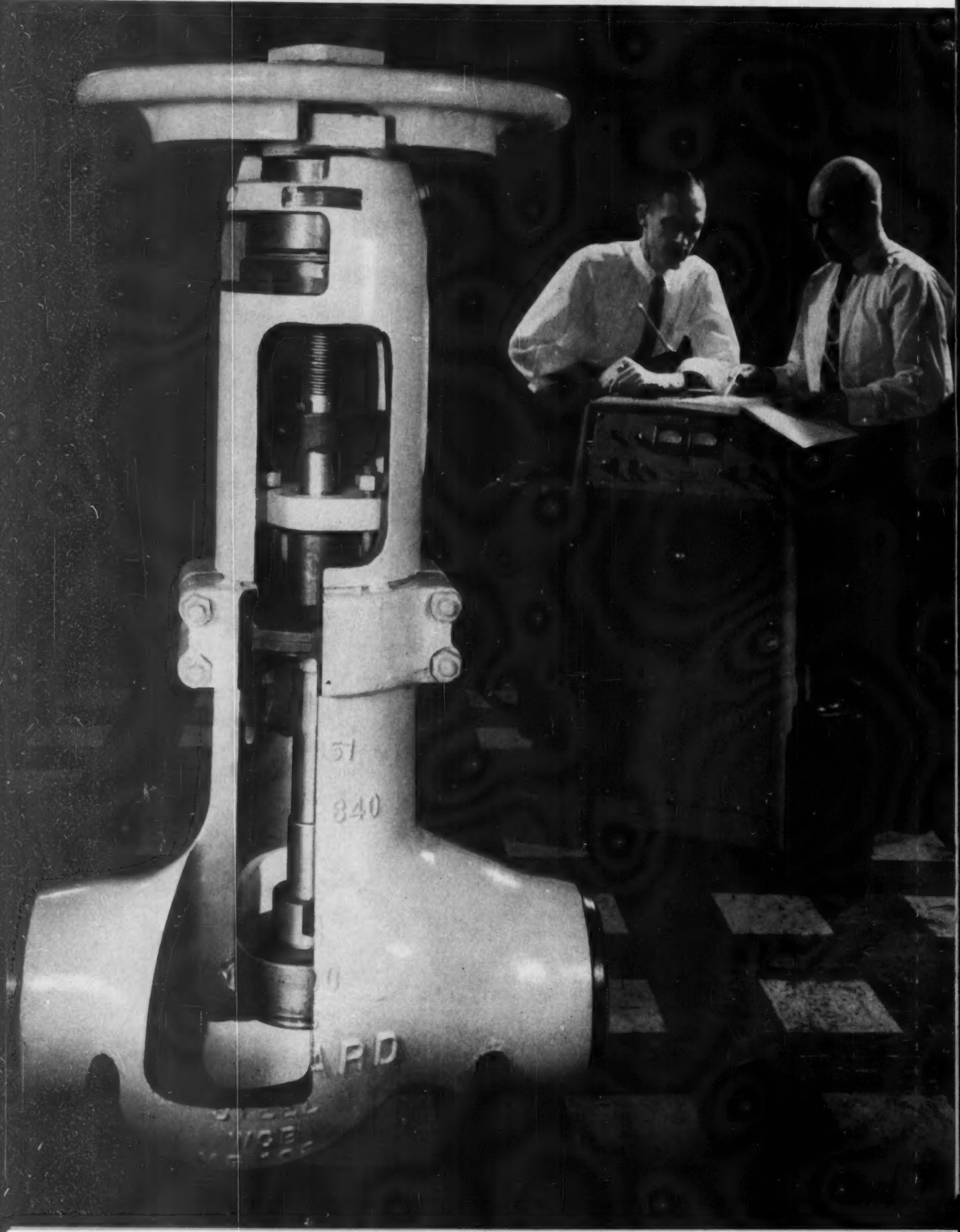
Mills: Rome, N. Y.; Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles, Riverside and Santa Ana, Calif.; New Bedford and Plymouth, Mass.; Brooklyn, N. Y.; Newport, Ark.; Ft. Calhoun, Neb. Sales Offices in Principal Cities.

Distributors Everywhere

INTEGRAL FINNED TUBE • BIMETAL TUBE • DUAL GAUGE TUBE • INSTRUMENTATION TUBE • CONDENSER TUBES IN CUPRO-NICKEL, ALUMINUM BRASS, ADMIRALTY, HERCULOY (Silicon Bronze), ARSENICAL COPPER, MUNTZ METAL AND OTHER ALLOYS • ALUMINUM TUBE, SHEET AND EXTRUSIONS • SMALL AND LARGE PLATES IN CUPRO-NICKEL, COPPER, HERCULOY, MUNTZ METAL, NAVAL BRASS AND ADMIRALTY • LOW CARBON STEEL HEAT EXCHANGER TUBE TO ASTM SPEC. A-214 AND A-334 GRADE "C" • BOILER TUBE TO ASTM SPEC. A-178

For more facts circle 208 on Reader Service card, p 107

The Story of Edward Research



and the Pressure-Seal* Valve

The introduction, in 1945, of commercial steel valves with pressure-seal bonnet joint construction was a significant advance in the art of building large high-pressure steel valves. The new pressure-seal construction eliminated massive flanged bonnet joint connections and made it possible to seal the valves permanently at high temperature. These advantages were immediately apparent to users everywhere. But bonnet joint leakage problems developed on the new valves in service. And Edward engineers soon became convinced that the original 45° pressure-seal gasket design used by Edward and others required improvement. Here's the Edward pressure-seal redesign story:

INITIAL TESTING—Edward engineers began their studies on leak problems in 45° gasketed pressure-seal valves by determining under what conditions the valves were most likely to leak. It was discovered that when sealing areas were thoroughly degreased and tested with air, the pressure seal would leak at all pressures above 10 psi. In addition, minute imperfections in the sealing area of the valve body bore were preventing intimate gasket contact and contributing to leakage. Edward engineers found that a broader area of contact between gasket and bonnet and between gasket and body bore would also reduce leakage. Further investigation showed that a gasket plating material softer than the silver plating previously used would be helpful in achieving better contact in the sealing area.

To obtain more gasket sealing area, experiments were conducted on gaskets with angles from 45° down to 17°. Over a period of several months, tests were made with 25 different combinations of gasket and bonnet angles and various gasket plating materials. Assembled valves were tested for tightness with air pressures ranging from 10 psi to 2160 psi, and at temperatures up to 1000 F for extended periods. And tests on ease of valve disassembly (an important user consideration) were made with each gasket combination.

TEST CONCLUSIONS—At the end of their extensive testing program on the pressure-seal design, Edward engineers were able to draw these conclusions:

1. 45° gaskets, which showed no leak on water tests, leaked air at similar pressures.
2. No gasket of any design, either plain or with a plating of 100 Brinell or harder, would seal air when assembled unlubricated.
3. The best sealing under test resulted with a 25° gasket angle which was 1° more acute than the bonnet angle.
4. Gaskets of 25° angle actually tripled the sealing surface area.
5. A stainless inlay in the valve body bore sealing area substantially improved gasket-to-body contact and provided a corrosion-resistant surface.
6. Gaskets of 25° angle, plated properly with a malleable coating, gave perfect air or steam sealing at all temperatures, whether assembled dry or with a lubricant.

NEW VALVE DESIGN—As the result of their tests, Edward engineers designed the completely new pressure-seal valve with 25°-65° joint (see diagram below). This change in gasket angle, with an increase in sealing surface area, and the addition of a special corrosion-resistant malleable coating, brought an end to bonnet joint leakage in Edward pressure-seal valves. And, since 1953, thousands of Edward pressure-seal valves have been installed in a great variety of services *without a single case of failure reported to date.*

The story of Edward research and the pressure-seal valve is typical of the kind of research progress and product leadership you can expect from Edward Valves. Edward builds a complete line of forged and cast steel valves from ⅛" to 18" for industrial, marine, petroleum and technological services. For more detailed information, contact your Edward Representative, or write Edward Valves, Inc., 1230 West 145th Street, East Chicago, Indiana. Subsidiary of Rockwell Manufacturing Company. Represented in Canada by Lytle Engineering Specialties, Ltd., 438 St. Peter Street, Montreal.

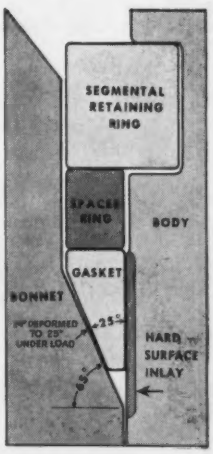
*Patented

EDWARD STEEL VALVES
another fine product by
ROCKWELL

P. J. DUKES, product development engineer, and D. MacGregor, works manager, are shown with helium leak detector used in testing pressure-seal valve joints.

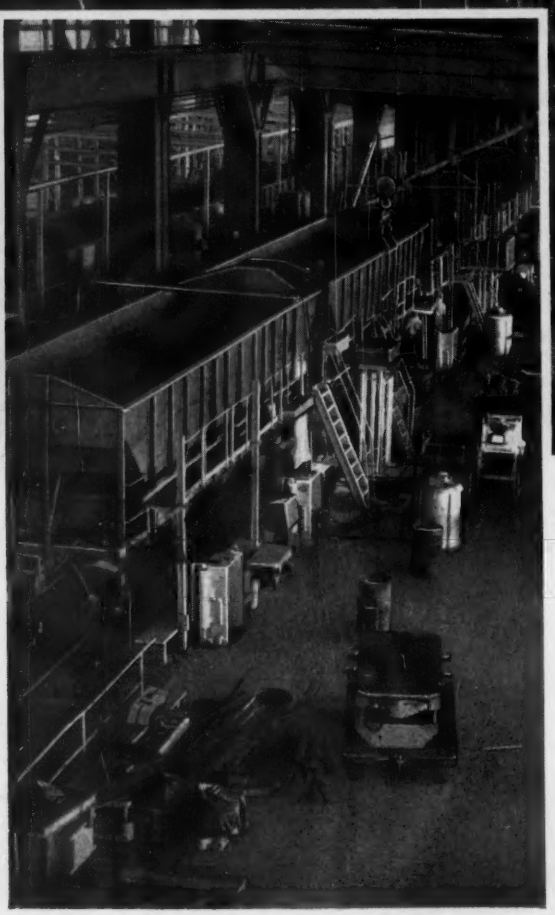
SPECIAL GAS-FIRED FURNACES were used in temperature testing of new pressure-seal valve design. Furnaces heated valves up to 900 F for 24 hour periods. Pressure was maintained with hydro-pneumatic pumps.

NEW 25° GASKET DESIGN

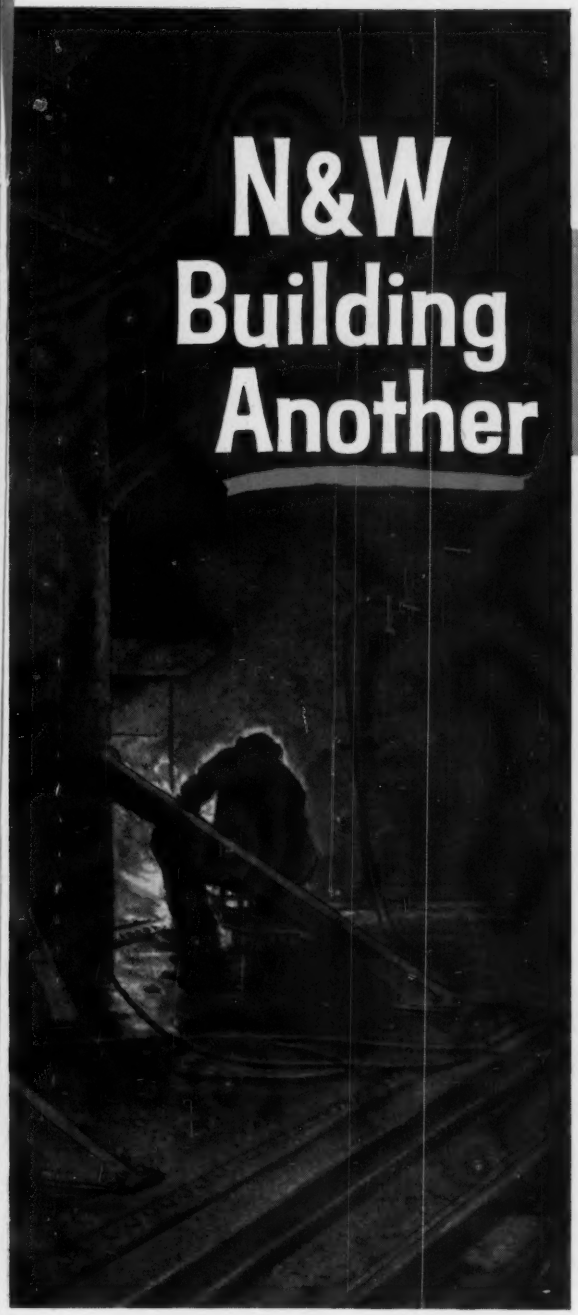


For more facts circle 209 on Reader Service card, p 107

Welders at Work on one of new 85-ton, roller-bearing hoppers. Some 781 feet of weld and 1,880 rivets are used. It takes about 250 man-hours to build each car.



Assembly Line of new cars in N&W shops. Twenty cars in an 8-hour day can be turned out at peak production. The 85-ton hoppers are 46′, 1½″ long . . . 10′, 6⅝″ wide . . . 11′ high . . . have light weight of 61,000 lbs.



N&W Building Another 1,000 85-Ton Coal Hoppers for better service!

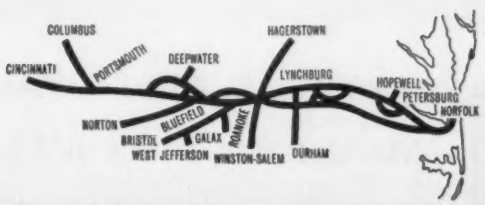
The N&W designed, built and placed in operation last year America's first 85-ton roller-bearing coal hopper cars. The original 1,000-car order is completed.

These husky haulers have proved so popular with shippers and users of coal, that the N&W has started construction of another 1,000 in its Roanoke, Va. shops. (Cost of the 2,000 — almost $24 million.)

These king-sized capacity cars mean the N&W can move more of your coal more efficiently than ever before — faster loading, hauling, delivery and unloading of bigger pay loads.

Constantly expanding coal handling facilities and constantly improved service are among the many good reasons why it pays to buy all-purpose, quality coals from mines along the N&W.

To get the full story, call or write the N&W coal traffic man in your area.

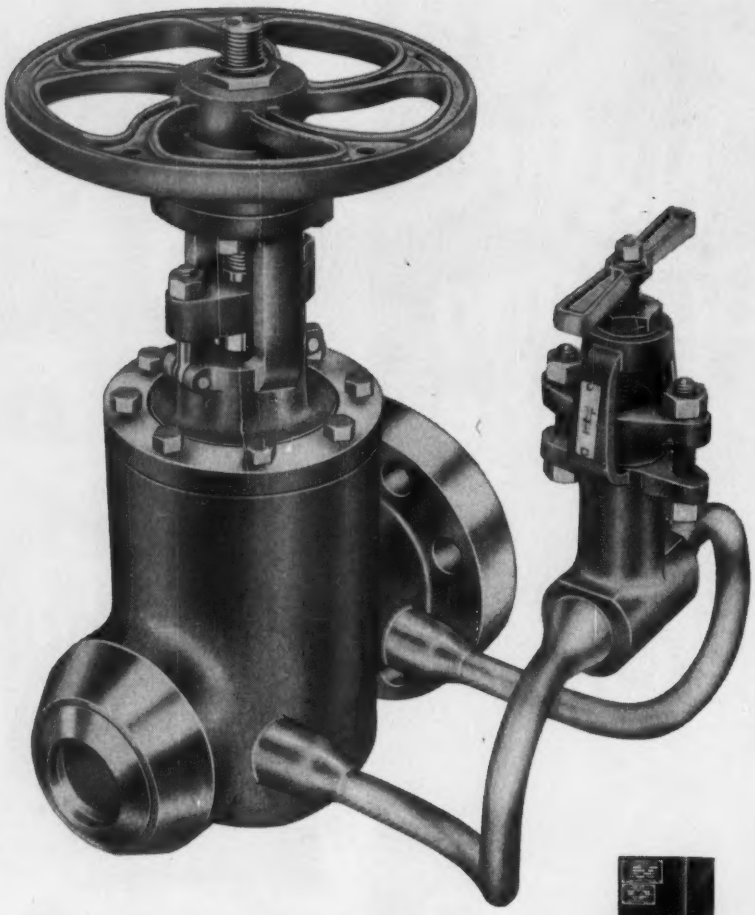


NORFOLK and WESTERN RAILWAY

N&W

GENERAL OFFICES • ROANOKE, VA.

NATION'S GOING-EST RAILROAD



New Hancock Isolation Valve

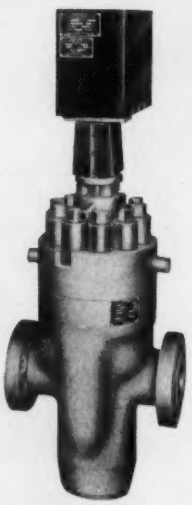
HELPS SIMPLIFY EMERGENCY REPAIRS

Specifically designed to isolate the Consolidated "Electromatic" Relief Valve from the boiler or superheater, this new Hancock Steel Isolation Valve reduces both repair costs and work time by permitting the unit to stay on the line.

Installed under the "Electromatic," the Hancock Isolation Valve utilizes a new type of pressure seal bonnet joint which employs internal system pressure to help provide an extremely tight seal.

The seal ring is not subject to full bonnet load. Seat rings, wedge, and back seating surface are Stellite-faced for long wear. The design is streamlined for clean piping installation. Can be furnished, as illustrated above, with By-Pass Valve to permit equalization of pressure on both sides of the wedge for easier opening.

Complete specification data sent on request. Write today.



Consolidated "Electromatic" Relief Valve. An automatic electrically-actuated valve that assures accurately balanced boiler operation at peak loads and more uniform line pressure. It saves steam, pure water, fuel, and "wear and tear" on spring-loaded valves. It can also be set to operate before the safety valves and thus becomes the working valve.

MAXWELL MM& MANNING & MOORE INC. TRADE MARK

HANCOCK STEEL VALVES

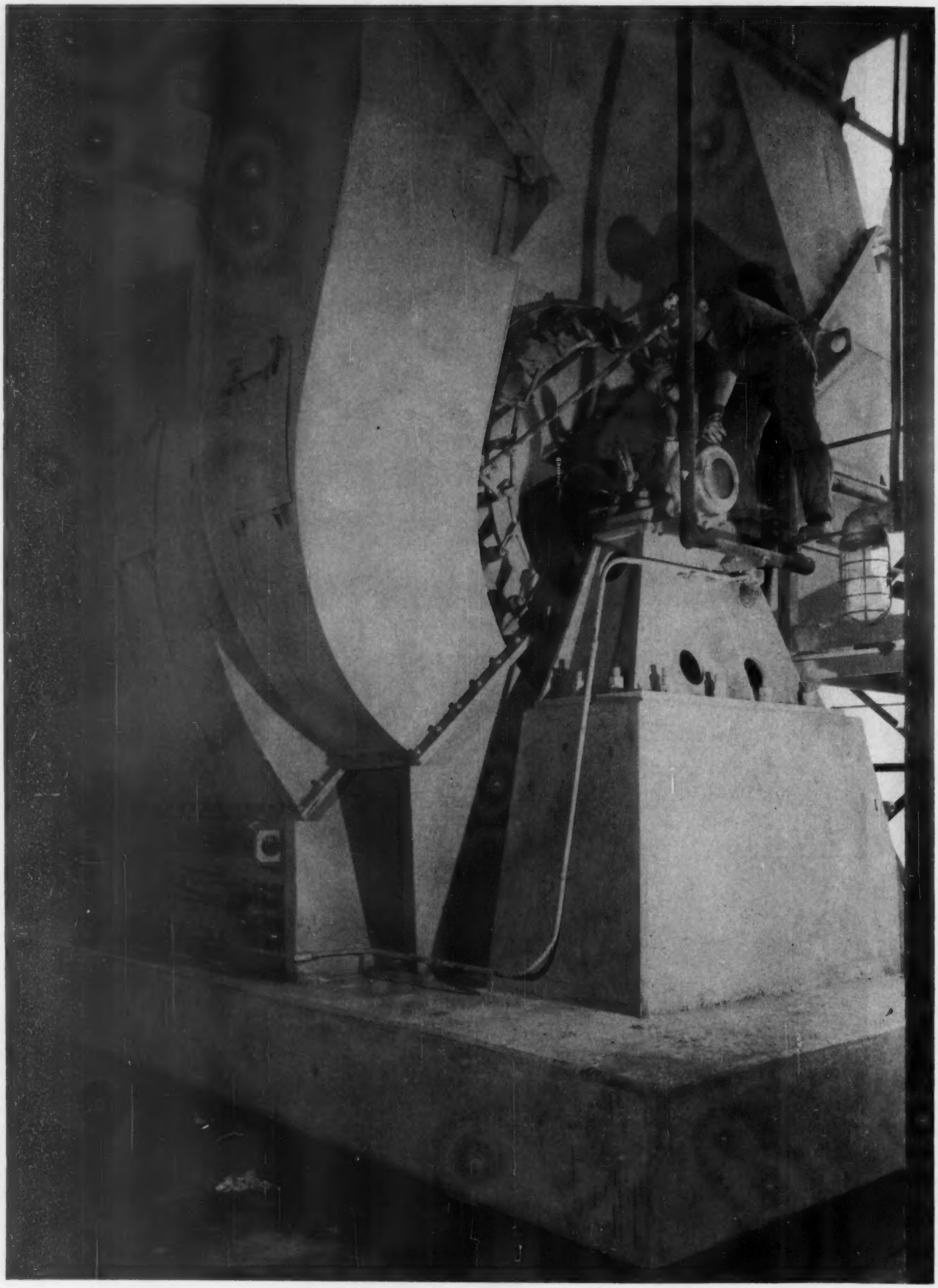
A product of

MANNING, MAXWELL & MOORE, INC.

Valve Division • Watertown, Massachusetts
Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario
Latin America: Export Division, Chrysler Building, New York, N. Y.
Europe: Manning, Maxwell & Moore, S.A., Fribourg, Switzerland

Morton Purex Salt ships and stores without caking. It is available from coast to coast. It is 99.5% Sodium Chloride—and 100% soluble. To produce a fully saturated brine efficiently, automatically, and at highest possible flow rates, specify Morton Purex Salt. **MORTON SALT COMPANY**

Industrial Division, Dept. P8, 110 N. Wacker Drive, Chicago 6, Ill.



RD Fan used for induced draft on basic oxygen furnace of large steel producer. There are four identical units, each producing 325,000 cfm against a static pressure of 15" wg at 550° F.

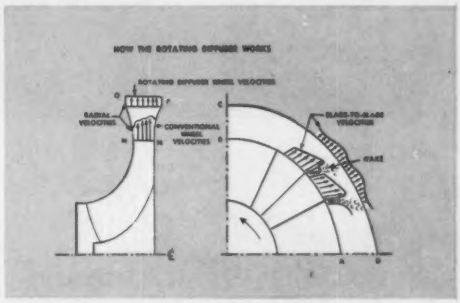
JOY RD FANS CAN PROVIDE PRESSURES UP TO 4.5 PSI AND CAPACITIES UP TO 600,000 CFM

Joy RD Centrifugal Fans, based on a new concept in fan design, can provide any volume of air or gas at pressures up to 4.5 psi in a single stage. This means important savings in initial cost. An equally important saving is their high efficiency over a wide range of volume, which is especially important where load fluctuates. Surging, even on parallel operation, is no problem because the RD Fan is inherently resistant to pressure surge over its entire duty range.

These advantages of the RD Fan are the results of its unique rotating diffuser. Instead of stationary diffusers, the RD diffuser is an integral part of the wheel—added at the blade tips. The rotating diffuser reduces the gas velocity before leaving the wheel and up to 98% of the conversion of velocity to pressure is accomplished with the wheel of the RD Fan.

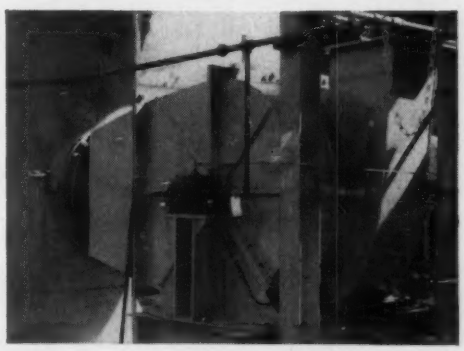
Radial blades in the RD Fan tend to be self cleaning, even when handling dust laden and dirty gases. The rotating diffuser results in low noise levels because of the lower and more regular velocities leaving the wheel and because the blade tips are remote from the cut-off.

The Joy RD Fan is finding steady acceptance in induced draft and forced draft applications in the steel and power industries, in handling chemical process gases, and in heavy duty industrial applications. For extremely dirty or corrosive applications the entire unit may be fabricated of stainless steel. Parts are simple because there are no large castings or close running tolerances. For complete information and duty areas of the RD Fan, write for bulletin 3449-16.



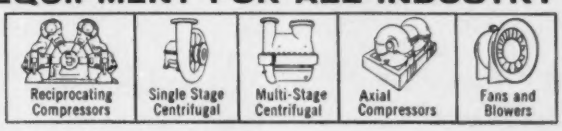
HOW THE ROTATING DIFFUSER WORKS

Studies have shown that radial velocities leaving conventional wheels are unequally distributed, as shown in MN. Also there is fluctuation in the blade-to-blade velocities based on $\frac{nN}{60}$ where n is the number of blades and N is the speed in rpm. The Rotating Diffuser reduces the gas velocity before leaving the wheel, which allows more uniform flow as shown at OP and CD. Without the rotating diffuser, velocities are much higher and erratic as shown at AB and MN, causing turbulence, friction losses.



Joy RD Fan at eastern CO_2 plant. Unit has capacity of 27,800 cfm, at 3 psi. Drive is a 450 hp steam turbine.

AIR MOVING EQUIPMENT FOR ALL INDUSTRY



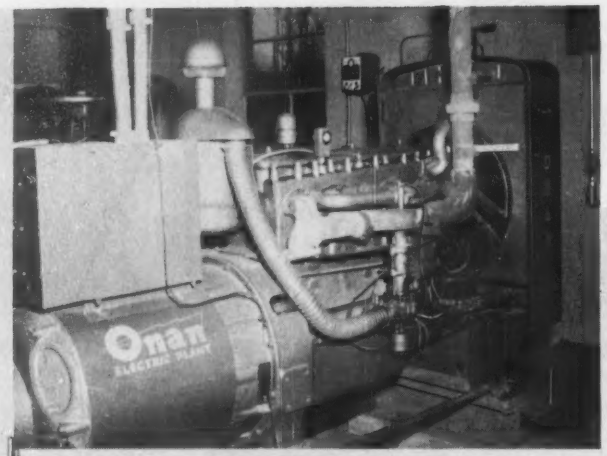
JOY

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

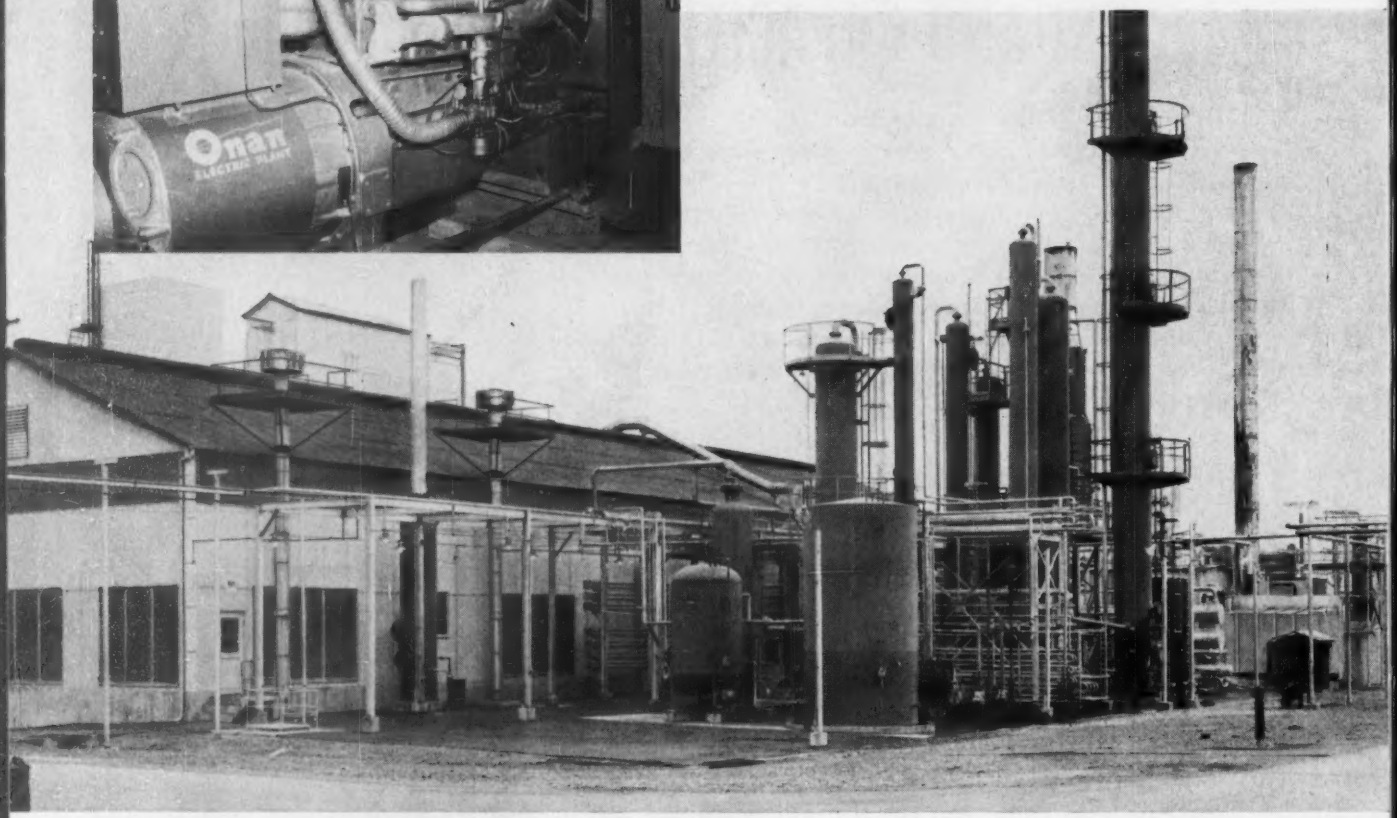
In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

For more facts circle 213 on Reader Service card, p 107

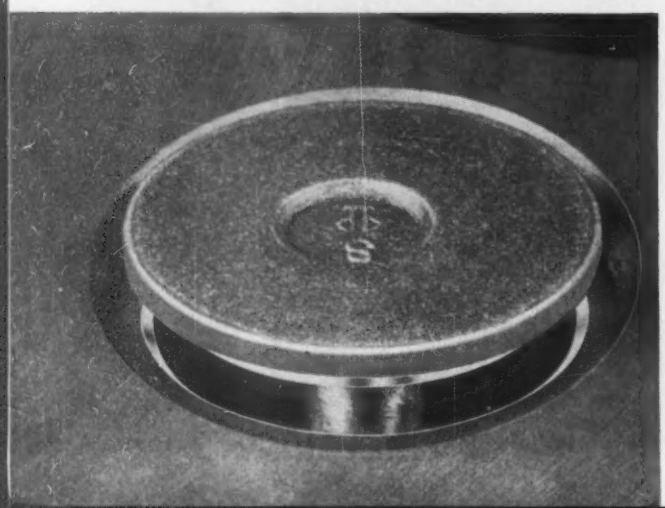
Beefed up for hardest



For portable electric power or standby for critical process, you can't afford to gamble on auxiliary power failure. That's why Onan gives every plant the toughest possible tests before it's shipped to you. *Only* Onan is certified to deliver every watt of power the nameplate promises. Before you buy any electric plant, talk to your Onan distributor. He's in the Yellow Pages.



Stellite coated exhaust valves and valve seats. One of toughest alloys known. Gives you up to 300% longer valve life than uncoated valves. It's the important details like this that make Onan more economical in the long run.



Exacting standards govern manufacture—years of specialized experience and extensive testing facilities control the quality of Onan Power Plants. Over 1000 different types and sizes of plants are produced by Onan.

use...even abuse

Onan electric plant still delivers full power after 12,197 hour test—equal to 487,888 miles

A grueling endurance test that lasted one year, nine months and 12 days could not stop Onan test plant #1068. Onan engineers used this production-built unit for an endurance run—and after it was all over, it still generated the full rated power promised on the nameplate. Proof that Onan's exacting standards and production testing give you a power plant with long, dependable life built in.

Over 1,700 other endurance units have been run by Onan engineers. In these tests every design feature and part has to prove itself before it can become a part of the Onan you buy. In addition, every type and size Onan plant is tested under all operating conditions which could conceivably affect performance on your job.

Hours of running in and testing under full load are given *every* Onan before it is shipped. An independent testing laboratory then spot tests Onan Plants that have already been tested by Onan—double assurance that every Onan will deliver its full nameplate rating. Only then does an Onan production run qualify for Performance Certification.

Buy *proven performance* when you buy an Electric Plant. See your authorized Onan distributor or dealer. You can depend on him for a lifetime of factory parts and service. He's listed in the Yellow Pages.

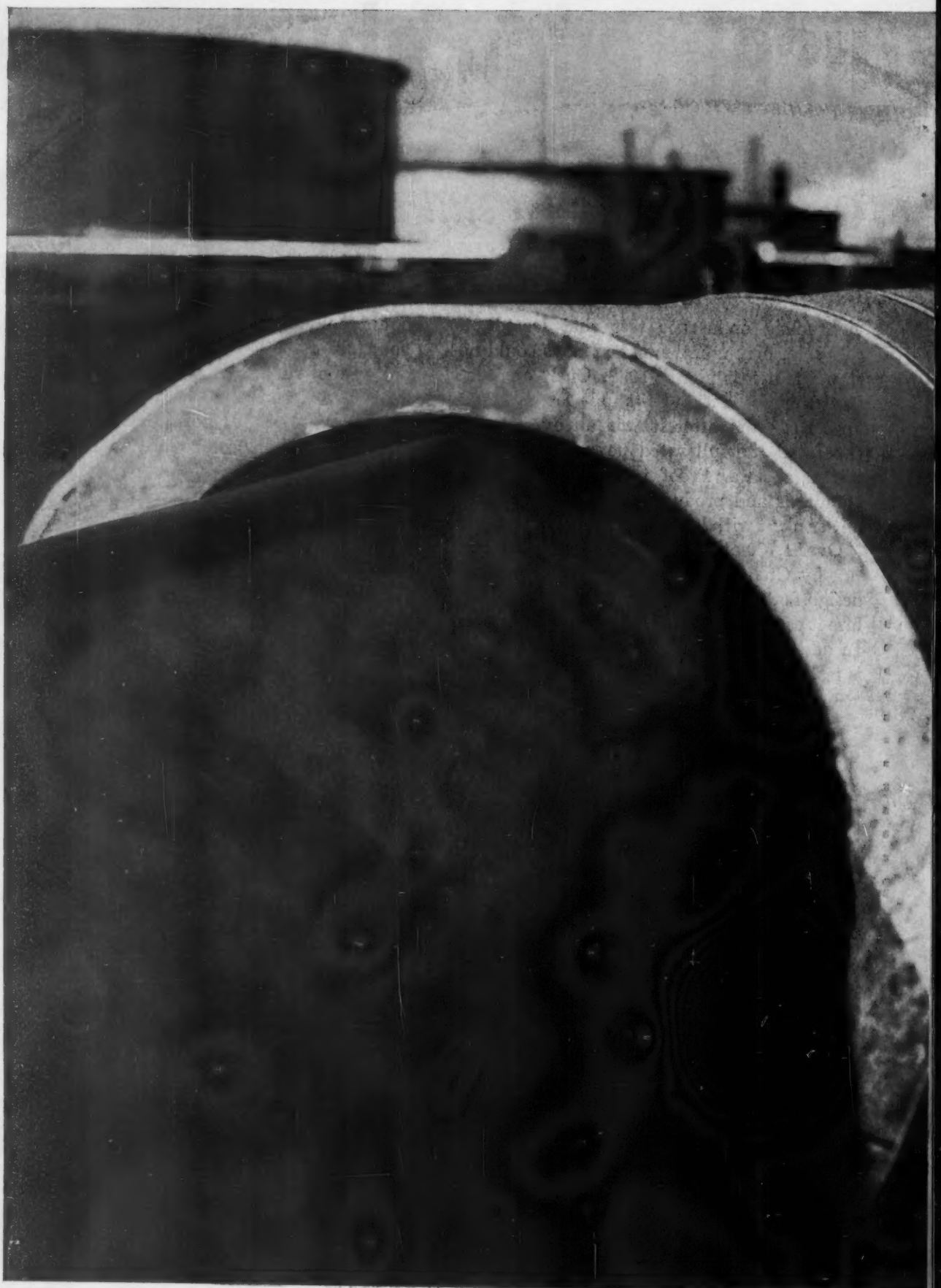
ONLY ONAN GIVES YOU THIS CERTIFICATION

Onan
Onan
PERFORMANCE CERTIFIED
We certify that when properly installed and operated this Onan electric plant will deliver the full power and the voltage and frequency regulation promised by its nameplate and published specifications. This plant has undergone several hours of running-in and testing under realistic load conditions, in accordance with procedures certified by an independent testing laboratory.

World's Leading Builder of Electric Power Plants

ONAN DIVISION, STUDEBAKER-PACKARD CORPORATION • 2681 UNIVERSITY AVE. S. E., MINNEAPOLIS 14, MINNESOTA

For more facts circle 214 on Reader Service card, p 107



Oval "overcoat" for a problem pipeline

J-M METAL-ON
in "long-legged" form cut insulation costs for Shell Oil

A piggy-back steam tracer line made insulating asphalt pipelines at Shell Oil's Norco, La., plant a problem. Every foot of pipeline–if insulated in standard fashion–would have required insulation a size larger than normal. And there were miles of pipe involved.

Johns-Manville and its contract unit in New Orleans, McCarty-Branton, Inc., studied the problem and made an unusual recommendation. They suggested using elliptically shaped, "long-legged" Metal-On®, the aluminum-jacketed pipe insulation. This oval shaped pipe covering fit right over the asphalt pipes and the troublesome tracer line–and saved substantially in the cost of insulation.

Typically, Johns-Manville had the answer for this insulation problem. *Your* insulation jobs, too, will be solved best by Johns-Manville. For further information, write to J. B. Jobe, Vice-President, Johns-Manville, Box 14, New York 16, N. Y. In Canada, address Port Credit, Ontario. Worldwide, cable Johnmanvil.

JOHNS-MANVILLE

AN INSULATION FOR EVERY COMMERCIAL AND INDUSTRIAL USE

JOHNS-MANVILLE JM PRODUCTS

Close-up of line section showing steam supply line and ½" copper tube tracer atop main line before it is coated with material used to bond it to main pipeline.

SEND FOR FREE SAMPLE

Johns-Manville, Box 14
22 East 40th Street
New York 16, N. Y.

Please send me a sample of Metal-On

NAME _____

TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE _____

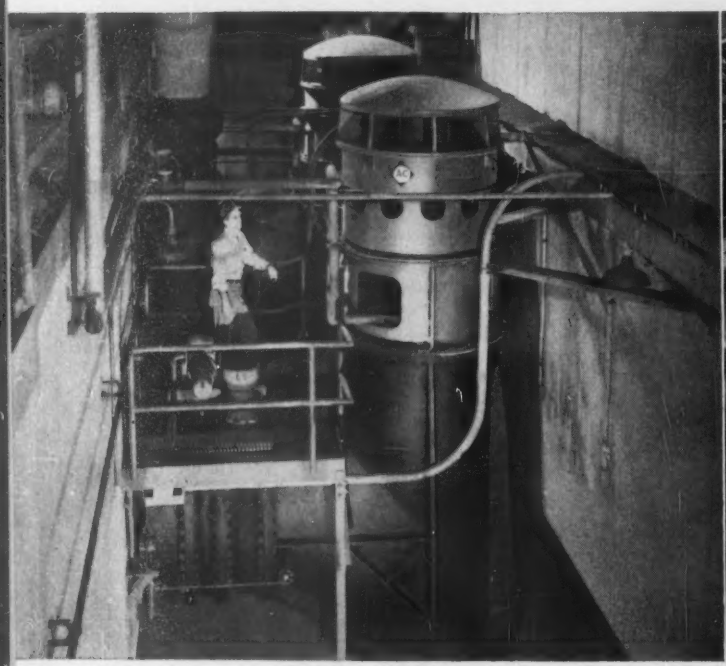
COUNTY _____ STATE _____

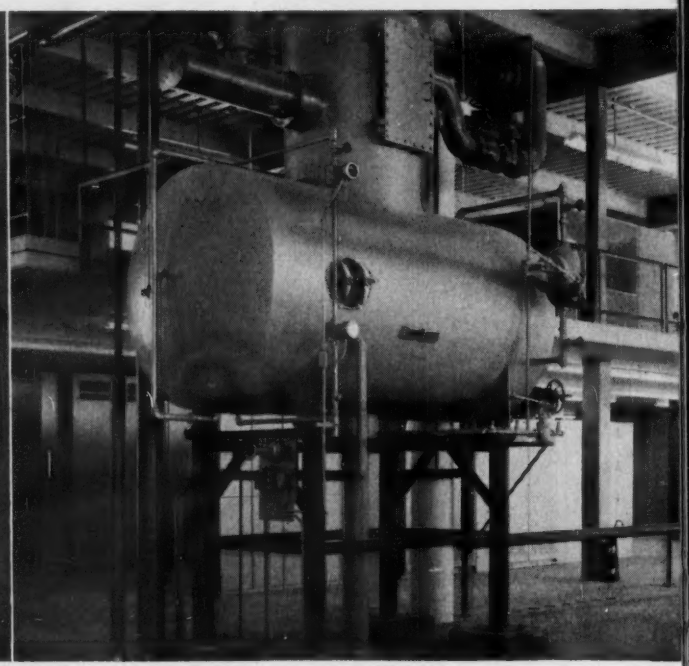
For more facts circle 215 on Reader Service card, p 107

Current news reports

WHAT'S HAPPENING IN POWER SERVICES?

Highlights: Switchgear with the lowest silhouette on the market. A "guided flow" condenser that slashes space requirements. These examples demonstrate the extra value that is standard with Allis-Chalmers . . . the greater efficiency and the added productivity that are yours when you buy A-C products, systems and services. Call your nearby Allis-Chalmers office for details or write Allis-Chalmers, Industries Group, Milwaukee 1, Wisconsin.

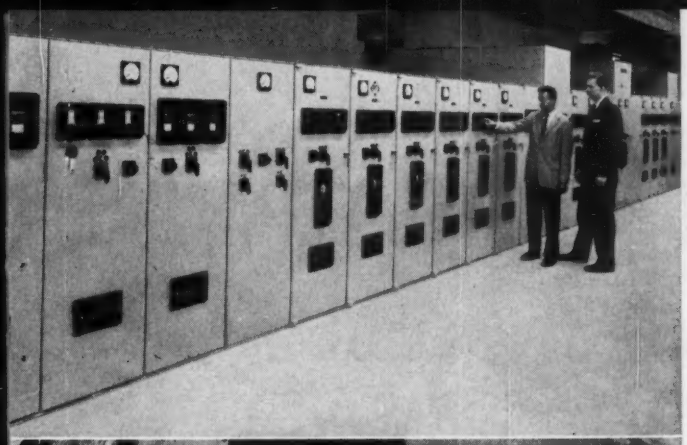




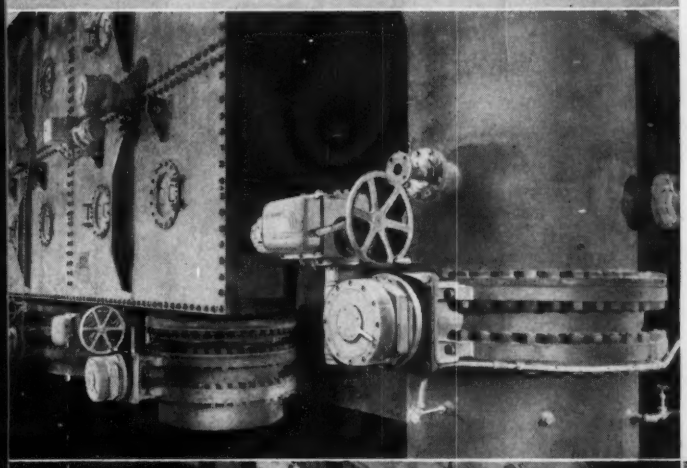
Rugged construction for continuous operation at highest possible efficiencies — yours with these condenser circulating water pumps and vertical induction motors. All pumps are tested at rated head and capacity to assure guaranteed performance. Available in a wide variety of materials to meet your installation needs. *Super-Seal* motors, with *Silco-Flex* insulation, assure complete reliability for outdoor installations and areas with high humidity or contaminated atmospheres.

Stainless steel "scorns" corrosion — It's standard with all Allis-Chalmers tray-type deaerator internals. This 90,000 lbs. per hour "package" unit removes oxygen and other corrosive gases besides heating boiler feedwater. Heating and distributing tray design provides greater spillage edge — extra-efficient air separating trays remove more oxygen and gases through full counterflow design. Protects boiler and associated steam and condensate equipment from corrosive attack.

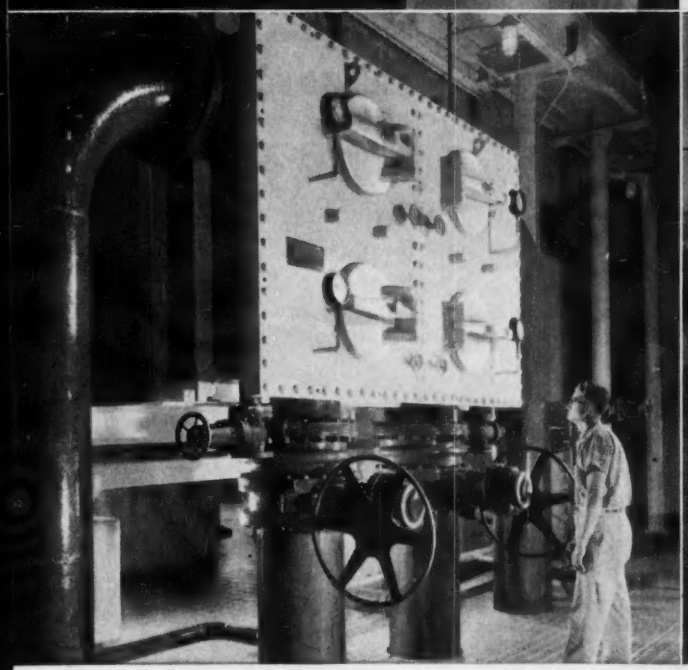
For more facts circle 216 on Reader Service card, p 107

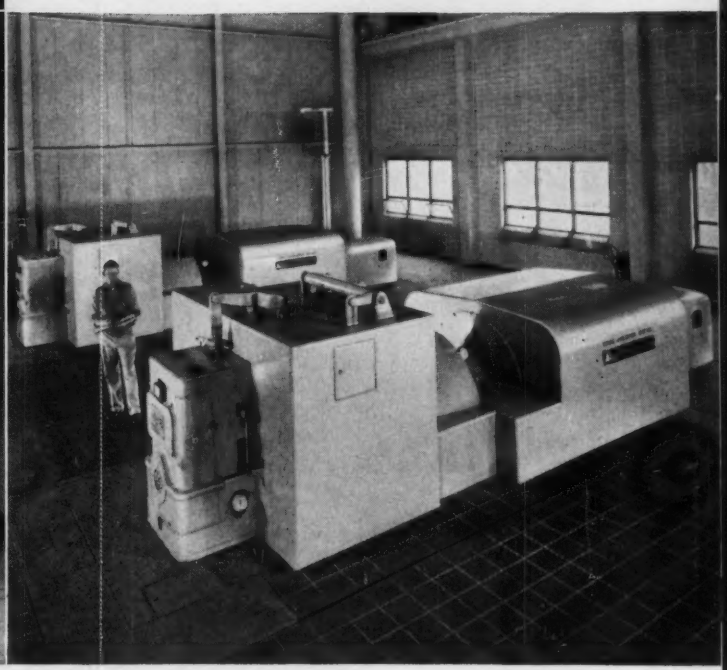


Lowest height, easiest access 5-kv metal-clad switchgear on the market. Just 72 inches high, you get eye-level instrumentation, shoulder-height accessibility of component parts. Other outstanding advantages: front-accessible current transformers; maximum compartmentation and dead-front construction for greater safety; full-panel metering; rapid, one-stroke breaker insertion. Choice of stored energy or solenoid operated circuit breakers.



Eliminate tuberculation and oxidation, reduce maintenance with rubber-seated butterfly valves. Operation is always extra-smooth and easy with 100% effective shutoff. Full body protection is offered by a rubber seat that extends through the valve body and over the flange faces. Angle seating protects the rubber seat and permits seating adjustment without costly disassembly. Being light and compact, these valves require less space and support than most other types.





Extra-compact rectangular steam condenser shape reduces space requirements. "Guided-flow" design achieves highest efficiency and vacuum with available water temperatures . . . gets maximum temperature condensate at the hotwell. Internal reverse-flow design for cooling water effectively backwashes debris, ends costly shutdown, conserves space, requires no additional piping. Planned-as-a-package auxiliary condenser equipment also available.

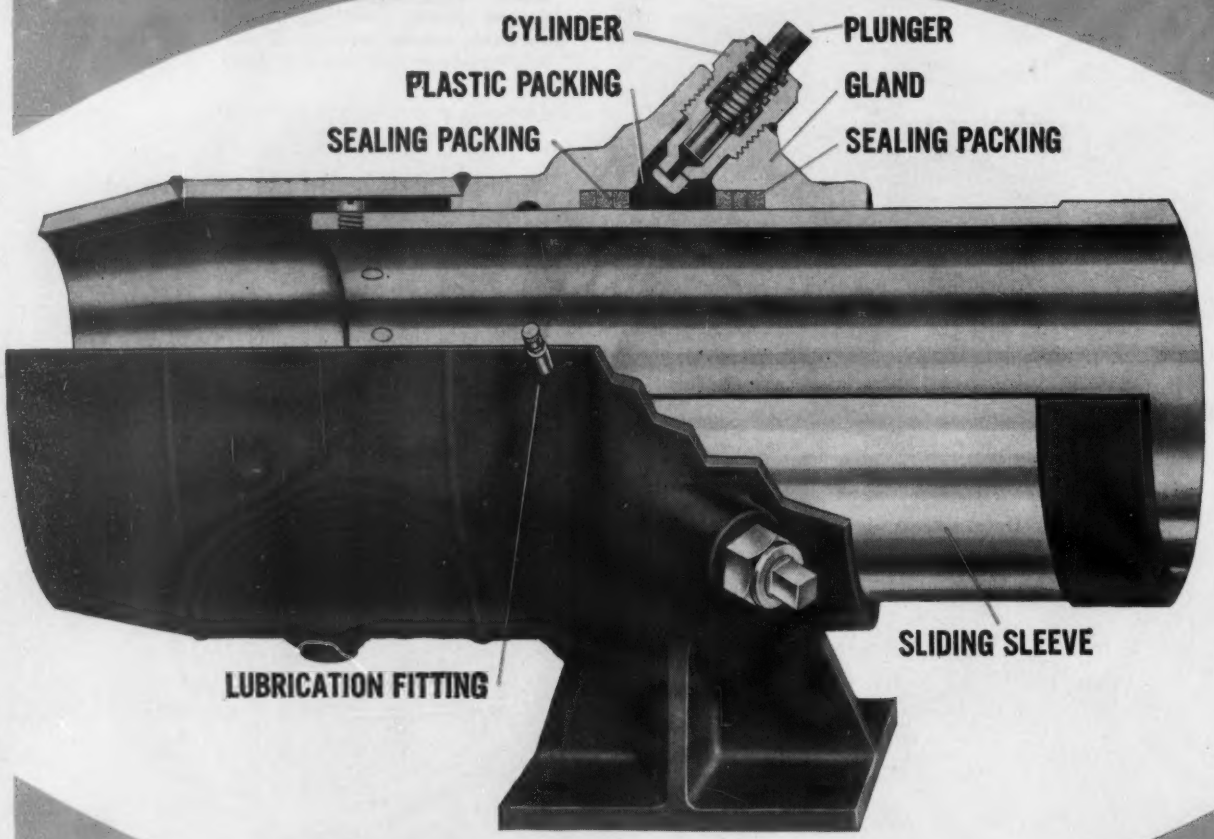
Two non-condensing, automatic extraction steam turbine-generator units (3000 kw) — for a hospital center where extraction and exhaust steam are used for heating and other services. You get the advantages of two steam pressures — high pressure by automatic extraction and low pressure from the exhaust. Use of pressure-reducing valves and desuperheaters is minimized where a wide range of process pressures is desired.

Super-Seal and Silco-Flex are Allis-Chalmers trademarks.

ALLIS-CHALMERS

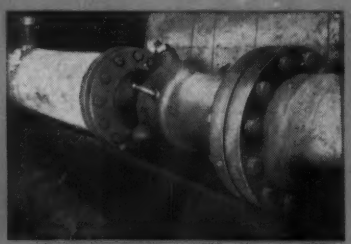
A-1479

GIVE STEAM and HIGH TEMPERATURE

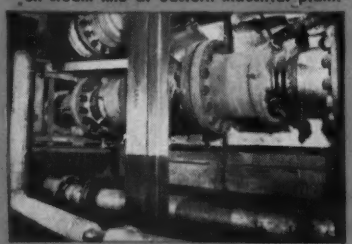


Only Yarway GUN-PAKT combines these outstanding features with design simplicity. GUN-PAKT Joints are available in single or double ends, welding or flanged, and in standard pipe sizes up to 30".

● 5 of 36 Yarway Gun-Pakt Joints, 2½" to 16" sizes, welding ends on steam lines at mid-west state institution.



● 6" Yarway Gun-Pakt Joint, flanged ends, on steam line at eastern industrial plant.



● Two 10" Yarway Gun-Pakt Joints, flanged ends, on return line of high temperature water system at New Jersey industrial plant.

● Group of 8" Yarway Gun-Pakt Joints, with automatic lubrication, on high temperature water lines at large international airport.

WATER LINES THESE BENEFITS...

✓ *TROUBLE-FREE SERVICE*
✓ *LOW MAINTENANCE*
✓ *SIMPLIFIED DESIGN*

WITH YARWAY GUN-PAKT EXPANSION JOINTS

Only Yarway GUN-PAKT Expansion Joints offer *simplicity, efficiency,* and *freedom from the "headaches"* that plague many plant engineers. That's why more engineers are specifying Yarway for efficient operation of steam and high temperature water piping in industrial plants, institutions and universities.

Yarway GUN-PAKT Expansion Joints offer you these advantages:

CONTINUOUS SERVICE—Shutdowns are eliminated. Addition of packing is seldom necessary, but may be added *under full line pressure.* No vents. Never needs repacking. *One plant lost, through forced shutdowns, production valued at $25,000. a day—until joints were replaced with Yarway* GUN-PAKT.

RUGGED DEPENDABILITY — All-steel construction with durable, chromium-plated, seamless steel sleeves. No chance of *metal fatigue.* Wrought steel bases provide rugged, positive anchorage.

INTERNAL AND EXTERNAL GUIDES—Positive alignment of sleeve in stuffing box—*where it counts.*

LIGHT WEIGHT, STREAMLINED DESIGN—Requires less space to install, less space to maintain, smaller manholes, fewer joints needed per length of pipeline.

MINIMUM MAINTENANCE—Many GUN-PAKT Joints have been *in service over 25 years with only nominal maintenance*—no major repairs or periodic overhauls. NEVER A SHUTDOWN FOR REPACKING. Maintenance records show an average of one manhour and 65 cents worth of packing needed per joint per year.

Why don't *you* investigate the advantages of GUN-PAKT Joints now? A Yarway engineer will be glad to discuss the subject with you. Invite him to call. Ask for Yarway Bulletin EJ-1917, too.

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY

For more facts circle 217 on Reader Service card, p 107

BEHIND THE MACHINE . . . in small steam turbines

PROGRESS in the development of turbine-generators has been continuous at AEI for over fifty years. A progressive research policy solves the problems of manufacturing more reliable, more efficient and more versatile turbines and generators. Speedy delivery and competitive prices are other factors that contribute to AEI'S leadership in this field of manufacture.

Advanced research techniques and modern experimental equipment have led to the development by AEI Turbine-Generator Division of blade forms that have helped to reduce flow losses in steam passages to a new minimum.

AEI Turbine-Generator Division makes **geared turbine-generators** from **300** kW and **direct-coupled** machines from **500** kW. Designs include **back-pressure** and **extraction** machines. Geared sets can be **self-contained** with the condenser integral with the exhaust casing.

Produced by AEI Turbine-Generator Division, Britain's largest manufacturer of turbine-generators.

AEI **Associated Electrical Industries Export Ltd**

33 GROSVENOR PLACE, LONDON SW1

B/L004/1

How Nalco® High-Performance Coagulants Can Cut Your Water Treatment Cost... And Give You Better Water, Too!

Proper Clarification of Water Delivers Savings Throughout the System

Have you examined your clarification system on a realistic cost-performance basis lately? Have you taken into consideration rising costs of materials *and* labor? Such an analysis is the only valid method of determining what coagulation is costing you today.

Here at Nalco, it has been our experience that high performance Nalco coagulants show up the expense and inefficiency of older coagulation methods. An overall evaluation often shows that the "low-cost-per-pound" coagulants cost more per thousand gallons of clear, sparkling water... (water they will seldom deliver except under ideal conditions).

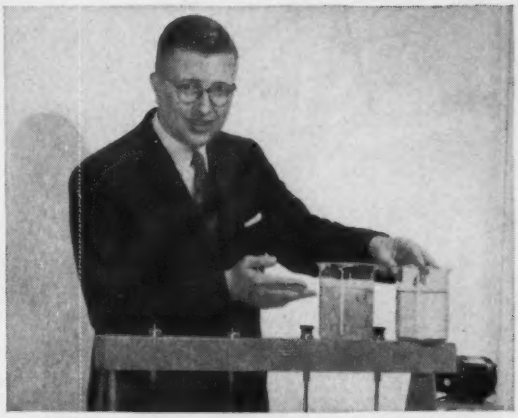
Efficient clarification is extremely important as a safeguard against high treatment costs in your supply lines, process equipment, cooling systems and boilers. Therefore, in assessing a clarification program, *all* factors affecting costs and potential savings must be considered . . . not overlooking freight, storage, feeding and performance figures.

Savings Begin with Chemicals to Fit the Job

Nalco's coagulant and coagulant aid chemicals are designed to fit feeding and water use requirements in both economy and performance. Sodium aluminate coagulants are: No. 2 Liquid, stable, highly-active and simple to proportion and use in liquid feeding equipment; Nalco 680 pure-white powder, ideal for use where chemical color is important; and Nalco 614 granular, high-activity, free-flowing sodium aluminate, used widely in municipal plants and other large-volume treatment applications. Nalco cationic, anionic and non-ionic polymer coagulants and coagulant aids are "heavy-duty" chemicals, used with Nalco sodium aluminates, with alum, or alone, depending upon the particular operating requirements of the system.

Savings Throughout the System

Fast formation of heavy, stable floc with Nalco coagulants and coagulant aids is basic in producing water that is trouble-free in use throughout the system. Some of the more common troubles Nalco-treated water prevent are: solids carryover of floc, sludge or alumina—and resultant plugging of pipes and equipment; corrosive or unstable water; and taste, odor and color carryover. While Nalco high-performance coagulants are not bactericides, bacterial content of efficiently treated water is significantly lower



J. T. Burke, Product Manager of Nalco Coagulant Chemicals Department, is a specialist in water clarification . . . One of the Nalco experts who have changed coagulation treatments from guess work to science.

because thorough coagulation traps a large percentage of microbiological organisms in the floc formation. As a result, waters need less bactericide treatment to meet requirements for low bacteria count.

Savings in Direct Chemical Costs

Chemical costs can be an important part of overall savings with Nalco high-performance coagulants and coagulant aids. The savings are significant in many plants. Two municipal plant superintendents report savings of $6,040* and $10,216* per year, respectively. A third plant reports that 1 ppm of Nalco 614 outperforms 10 ppm of alum*. In softening plants, chemical savings are often even greater, due to reduction in requirements for lime and soda ash, as well as coagulants.

**Itemized breakdowns of these savings are available on request. Also, there are probably similar figures on file for operating conditions closely parallel to your own.*

Savings with Expert Help

Nalco coagulation experts can cut the time and cost of setting up and proving out the coagulation chemicals and methods required to treat your water right. Nalco skills and experience in this field are unexcelled—and every Nalco Representative's basic products are water treatment results. Call him today, or write direct for Process Bulletin A1 . . . packed with facts and figures on coagulation in theory and practice.

NALCO CHEMICAL COMPANY

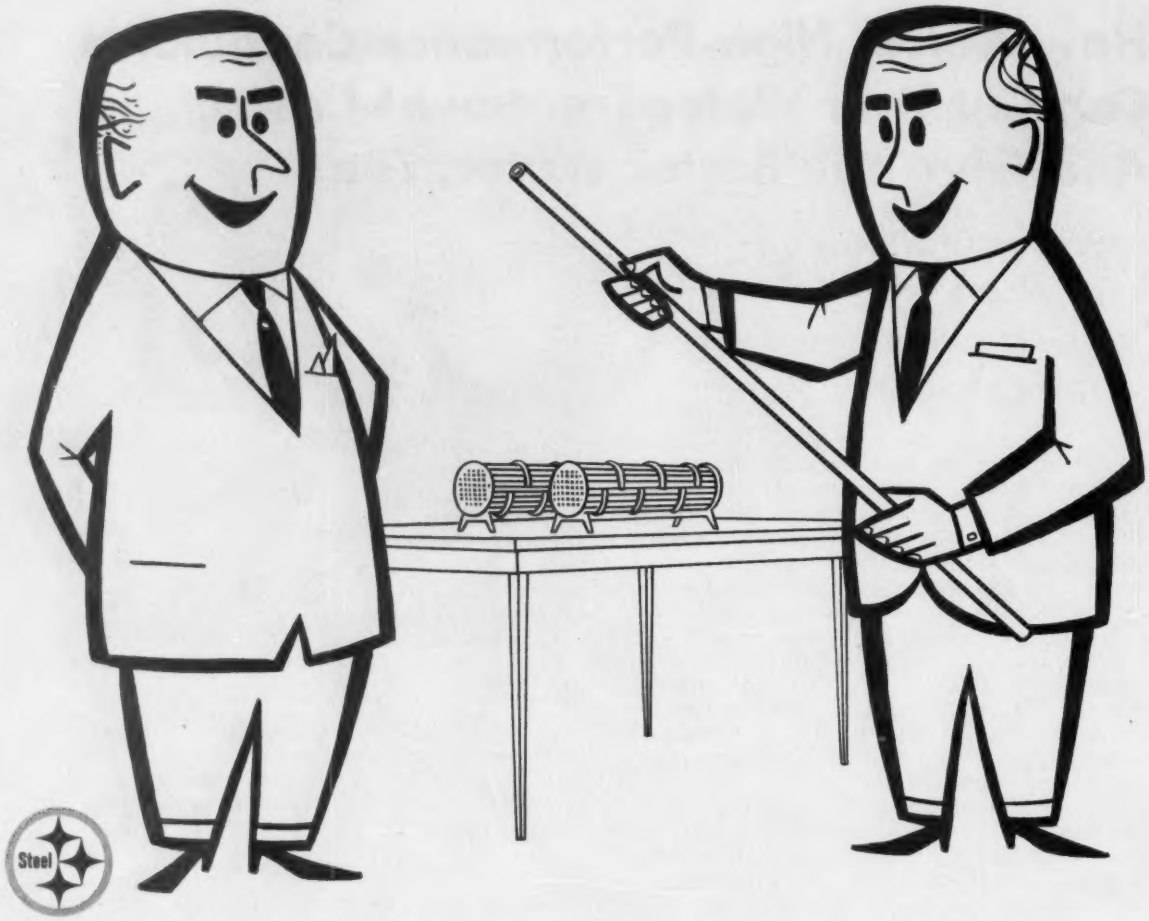
6222 West 66th Place • Chicago 38, Illinois

Subsidiaries in England, Italy, Mexico, Spain, Venezuela and West Germany

In Canada: Alchem Limited, Burlington, Ontario

Nalco® ...Serving Industry through Practical Applied Science

Nalco CHEMICALS
Nalco SERVICES
Nalco CHEMICALS
Nalco SERVICES
Nalco CHEMICALS
Nalco SERVICES
Nalco CHEMICALS
Nalco SERVICES
Nalco CHEMICALS
Nalco SERVICES
Nalco CHEMICALS
Nalco SERVICES
Nalco CHEMICALS
Nalco SERVICES
Nalco CHEMICALS
Nalco SERVICES
Nalco CHEMICALS
Nalco SERVICES
Nalco CHEMICALS
Nalco SERVICES
Nalco CHEMICALS
Nalco SERVICES
Nalco CHEMICALS
Nalco SERVICES
Nalco CHEMICALS
Nalco SERVICES
Nalco CHEMICALS
Nalco SERVICES



YOU GET LOWEST FINAL COST, OPTIMUM SERVICE LIFE

when you specify B&W Job-Matched Pressure Tubing

The cost saving dividends are greater—the design opportunities unlimited—when you make your selection from B&W's complete line of Job-Matched Pressure Tubing. To arrive at the tube that meets design as well as optimum cost requirements, you have a choice of seamless and welded in all grades and sizes of stainless, alloy or carbon steel. And when you need it, B&W provides the kind of unbiased assistance that only a full-line producer can give. Uniform dimensions, properties and steel quality are added values beyond standard specifications. As a result, B&W tubing saves on cost through easier fabrication, faster installation, greater operating efficiency and longer service life.

For a close look at final cost savings, contact your local B&W District Sales Office or write for Bulletin T-417. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pennsylvania.

B&W

THE BABCOCK & WILCOX COMPANY

TUBULAR PRODUCTS DIVISION

TA-1004-P

Seamless and welded tubular products, solid extrusions, rolled rings, seamless welding fittings and forged steel flanges—in carbon, alloy and stainless steels and special metals

PORTRAIT OF DEPENDABILITY

Undisturbed cobwebs tell a powerful story! Day in and day out, OIC steel valves take strain, vibration, pressure changes and shock in their stride. From the outside you get no hint of the precise manufacturing tolerances that make this trouble-free performance possible. OIC steel valves are designed to handle your steam, chemicals or hydrocarbons with minimum maintenance and maximum cost savings. Of this you can be sure . . . OIC steel valves are built to operate with complete dependability.

THE FINEST VALVES AND DISTRIBUTOR SERVICE FROM OIC

OIC VALVES

BRONZE, IRON,
FORGED STEEL,
CAST STEEL AND
DUCTILE IRON VALVES

INDUSTRIAL DISTRIBUTORS · SERVING INDUSTRY COMMERCIALLY · THE RIGHT HAND OF PRODUCTION

THE OHIO INJECTOR COMPANY, WADSWORTH, OHIO

The Ohio Injector Company 38818-OIC
251 Main Street, Wadsworth, Ohio.
Your story interests me. Please send more information about valves used in my industry.

Name _____
Company _____
Product _____
Street _____
City _____ Zone ___ State _____

For more facts circle 221 on Reader Service card, p 107

District Headquarters, The Austin Company, Cleveland.

When Engineer-Builders Build for Themselves . . .

IT'S JOHNSON PNEUMATIC CONTROL

These two buildings were built, for their own use, by men whose organization has designed, engineered, and built thousands of industrial plants and commercial buildings.

As it has done for so many of its clients, The Austin Company has provided its own personnel with buildings that are attractive as well as highly functional. Both buildings are air conditioned, of course. And both are equipped with specially planned Johnson Pneumatic Control Systems to assure a consistently comfortable and productive working climate.

Wherever quality and performance are the key considerations, as they so obviously were here, you will usually find Johnson Control . . . a fact well worth remembering when you build or air condition. Johnson Service Company, Milwaukee 1, Wis. 110 Direct Branch Offices.

JOHNSON CONTROL

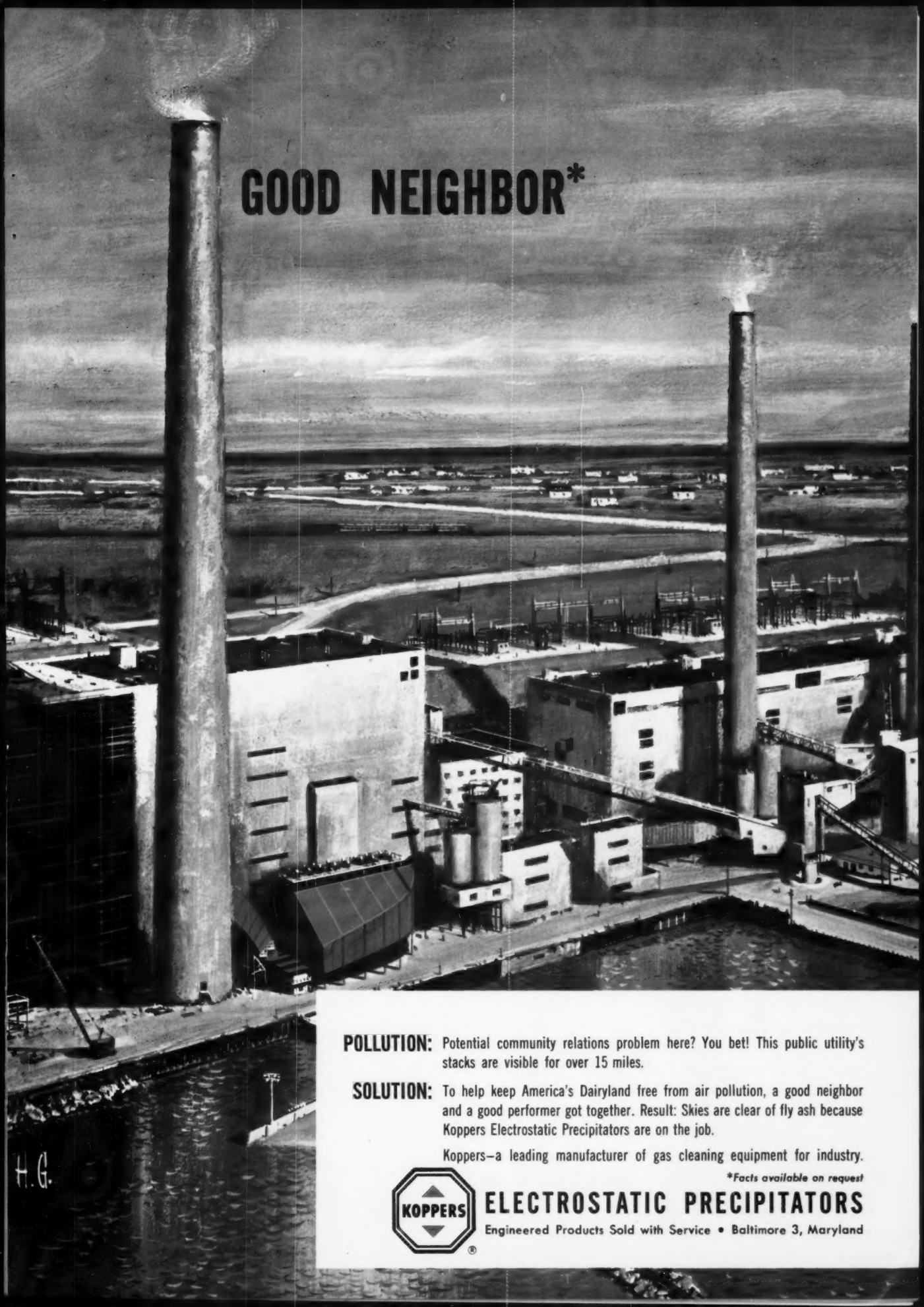
PNEUMATIC SYSTEMS

DESIGN • MANUFACTURE • INSTALLATION • SINCE 1885

General Offices, The Austin Company, Cleveland.

For more facts circle 222 on Reader Service card, p 107

circle 223 on Reader Service card, p 107 ➤



POLLUTION: Potential community relations problem here? You bet! This public utility's stacks are visible for over 15 miles.

SOLUTION: To help keep America's Dairyland free from air pollution, a good neighbor and a good performer got together. Result: Skies are clear of fly ash because Koppers Electrostatic Precipitators are on the job.

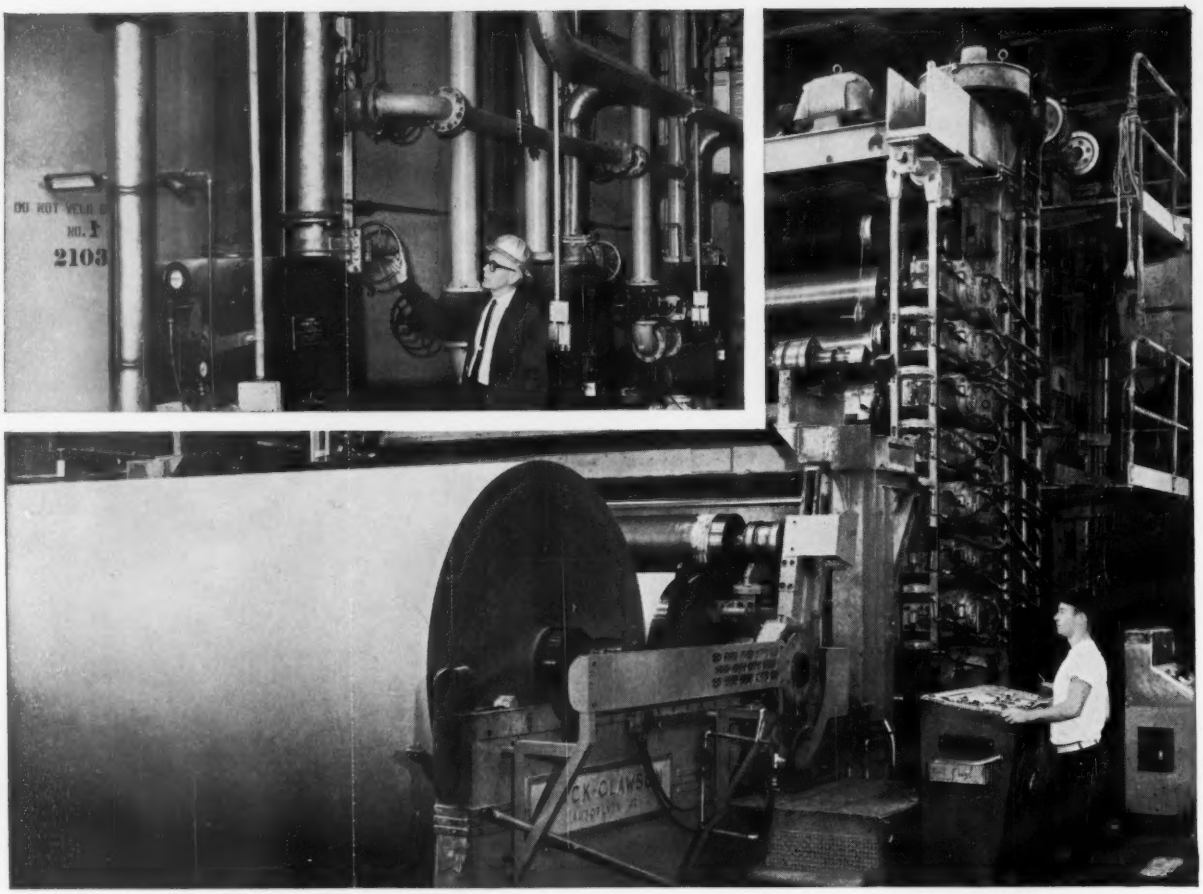
Koppers—a leading manufacturer of gas cleaning equipment for industry.

**Facts available on request*

KOPPERS®

ELECTROSTATIC PRECIPITATORS

Engineered Products Sold with Service • Baltimore 3, Maryland



INSET: Ion exchange units at Longview Fibre Company, Longview, Washington. Three 2-bed systems operate in parallel.

AMBERLITE® ion exchange resins still effective at Longview Fibre after treating 2,000,000,000 gallons of river water

Deionizing boiler makeup water for power generation at Longview Fibre Company, Longview, Washington, makes heavy demands on ion exchange resins. Raw water from Columbia River has high silica content (as much as 19 ppm SiO_2) and contains some organic material. Clarification requires heating, and water enters ion exchange beds at an elevated temperature of 95°-100°F.

Serving under these conditions, AMBERLITE IR-120 cation exchange resin and AMBERLITE IRA-400 anion exchanger operating in three 2-bed units have treated a combined grand total of over two billion gallons of water to date. Each cubic foot of anion exchange resin in two of these 2-bed units, installed in 1954, has treated over 4,300,000 gallons of water. (Third unit was installed in 1957.) Treated water has 750,000 ohms specific resistivity and only 0.03-0.05 ppm silica content.

The service AMBERLITE resins provide for Longview Fibre is typical of AMBERLITE performance in uses ranging from boiler water treatment to chemical processing. A broad selection of Rohm & Haas ion exchange resins lets you pick the right resin for any application. Write for technical literature and information.

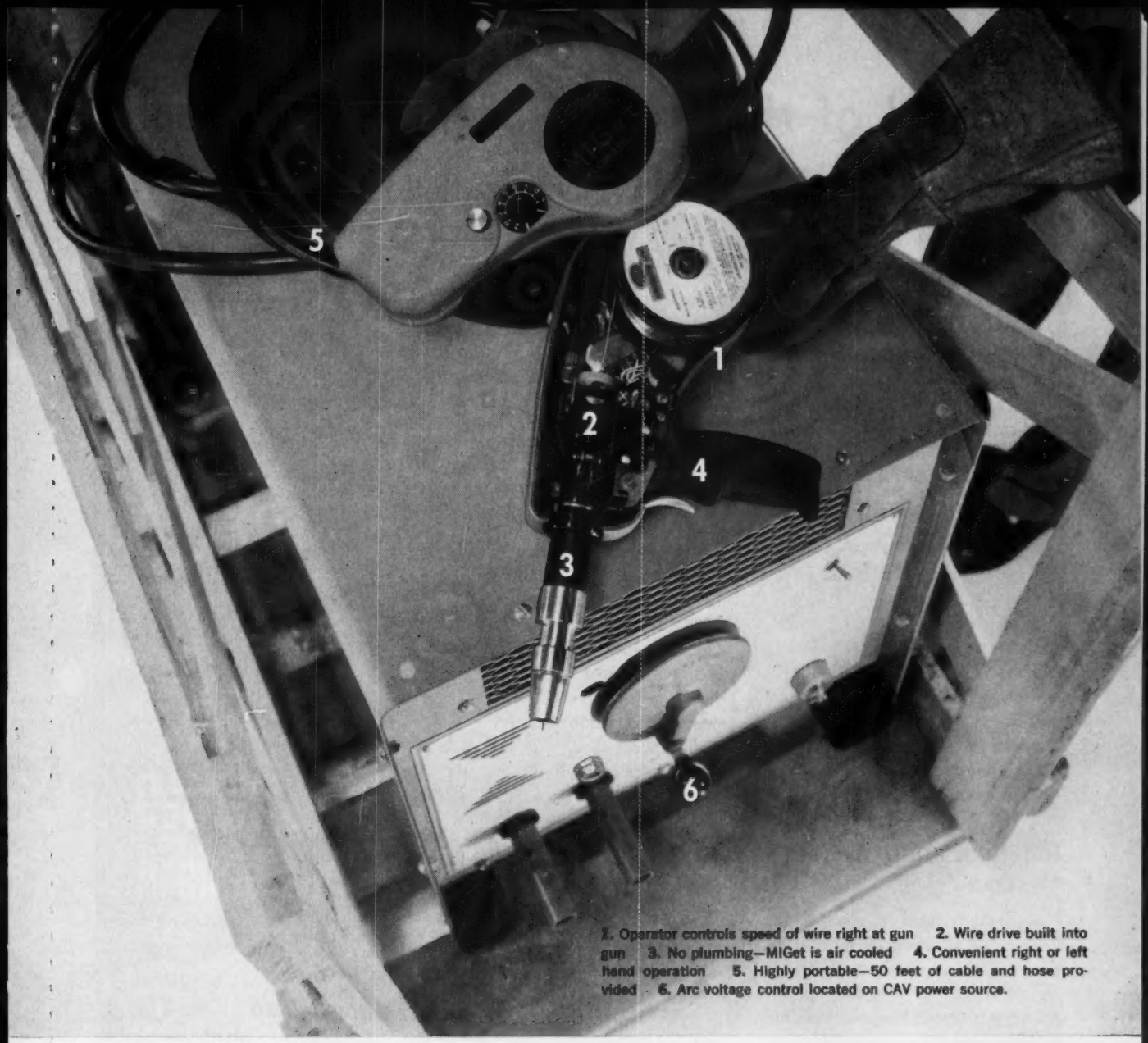
Booklet available free, shows how AMBERLITE ion exchange resins are used in many industries. Address your request to Dept. IE-7.

ROHM & HAAS

PHILADELPHIA 5, PA.

AMBERLITE

For more facts circle 224 on Reader Service card, p 107



1. Operator controls speed of wire right at gun 2. Wire drive built into gun 3. No plumbing—MIGet is air cooled 4. Convenient right or left hand operation 5. Highly portable—50 feet of cable and hose provided 6. Arc voltage control located on CAV power source.

DO HI-SPEED AIRCOMATIC WELDING ANYWHERE—$995*

with new MIGet UNIT PACKAGE! (no separate control needed) only

Airco now gives you the simplest, lowest price gas-shielded metal-arc welding package in the industry —

(1) Hi-speed highly portable MIGet welding gun, with handy knob to adjust wire feed speed; model AH20-E.

(2) New Aircomatic MIGet CAV power source, with control to adjust arc voltage.

The new MIGet UNIT PACKAGE enables you to make numerous short-length welds . . . at a remarkably low cost. You can work up to 50 feet from the power source, on anything from radar antennas to crawl-in tunnels.

You can weld mild steel with Dip Transfer using CO_2 or AG25; aluminum with Spray Transfer or Dip Transfer using argon; stainless steel with Dip Transfer using AG1.

The MIGet gun connects directly to the power source. It weighs only 2¾ pounds. Handles .030″ and 3/64″ aluminum wires, and .030″, .035″ and .045″ hard wires. It is rated at 200 amperes 100% duty cycle.

The power source, in which the "welding current takes care of itself," is a single phase, DC rectifier, CAV type, rated at 200 amperes 60% duty cycle. Reactance for Dip Transfer is built in.

Here is Aircomatic-quality gas shielded metal arc welding at an unmatched low price of $995!*

Airco — and only Airco — makes everything you need for any kind of welding. Call your nearest Airco office or Authorized Airco Distributor. Look in your Classified Telephone Directory under "Welding Equipment and Supplies" for your nearest Airco representative.

*Zone I price. Zone II price—$1015.00

AIRCO®

AIR REDUCTION SALES COMPANY

A division of Air Reduction Company, Incorporated
150 East 42nd Street, New York 17, N. Y.
More than 700 Authorized Airco Distributors Coast to Coast

On the west coast—Air Reduction Pacific Co., Internationally—Airco Co. Int'l., In Canada—Air Reduction Canada Ltd. • All divisions or subsidiaries of Air Reduction Co., Inc.

For more facts circle 225 on Reader Service card, p 107

(Advertisement)

Control of thermal expansion in piping

Flexible support can prevent destructive stresses in high temperature piping

Heat 100 linear feet of alloy steel pipe to 1000°F, and it will expand approximately 9 inches! When this thermal expansion takes place in a piping system, the resultant forces — if uncontrolled — can do incalculable harm.

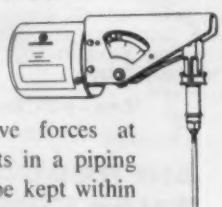
Helical coil springs

Using helical coil springs to compensate for thermal expansion in piping is now common practice. However, designing or selecting flexible supports is often done haphazardly. In fact, any specifications covering the support of important high temperature piping simply say "spring hangers shall be provided." But it is not enough to merely admit that thermal expansion may be dangerous.

Safety of entire system at stake

Careful study must be given to the design and selection of spring supports which will maintain a balanced piping system. If not, the transfer of weight from one hanger to another, or from a hanger to a terminal point, will endanger the safety factor of the entire system. Today, you're often confronted with 8–9–even 10 inches of thermal deflection. That's why flexible support for piping in all positions of travel is a definite "must"!

Constant-support hangers

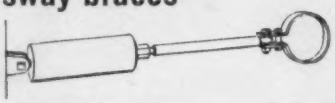


Where reactive forces at terminal points in a piping system must be kept within specified limits, Grinnell constant-support type hangers are recommended. They are designed to provide uniform supporting force equal to the pipe load throughout the range of thermal movement. Constant-support hangers should be used at superheater outlets, turbine connections, and on high temperature and other critical lines.

Variable spring hangers

When pipe lines are subject to vertical movement — and restrictive conditions do not require a constant-support hanger — variable spring hangers are recommended. They should be designed for a maximum variation in supporting effect of 25% for the total travel resulting from thermal conditions.

Vibration control and sway braces

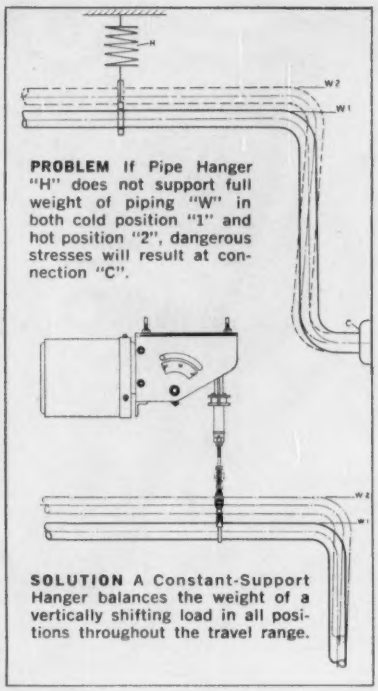


When you have to prevent abnormal movement or vibration in pipe lines, controls or sway braces of the energy-absorbing and instant-acting counter force type are recommended. They dampen vibration, oppose pipe sway, absorb shock.

Grinnell Hanger Engineering Service

Grinnell Company's Pipe Hanger Department offers design service to engineers who appreciate the specialized knowledge required. Grinnell will help you compute hanger loads . . . and select proper supports for a *balanced* pipe suspension system.

What's more, Grinnell manufactures a complete line of pipe hangers and supports — and offers stocks of pipe hangers close to any job!

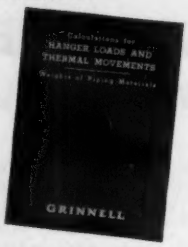


PROBLEM If Pipe Hanger "H" does not support full weight of piping "W" in both cold position "1" and hot position "2", dangerous stresses will result at connection "C".

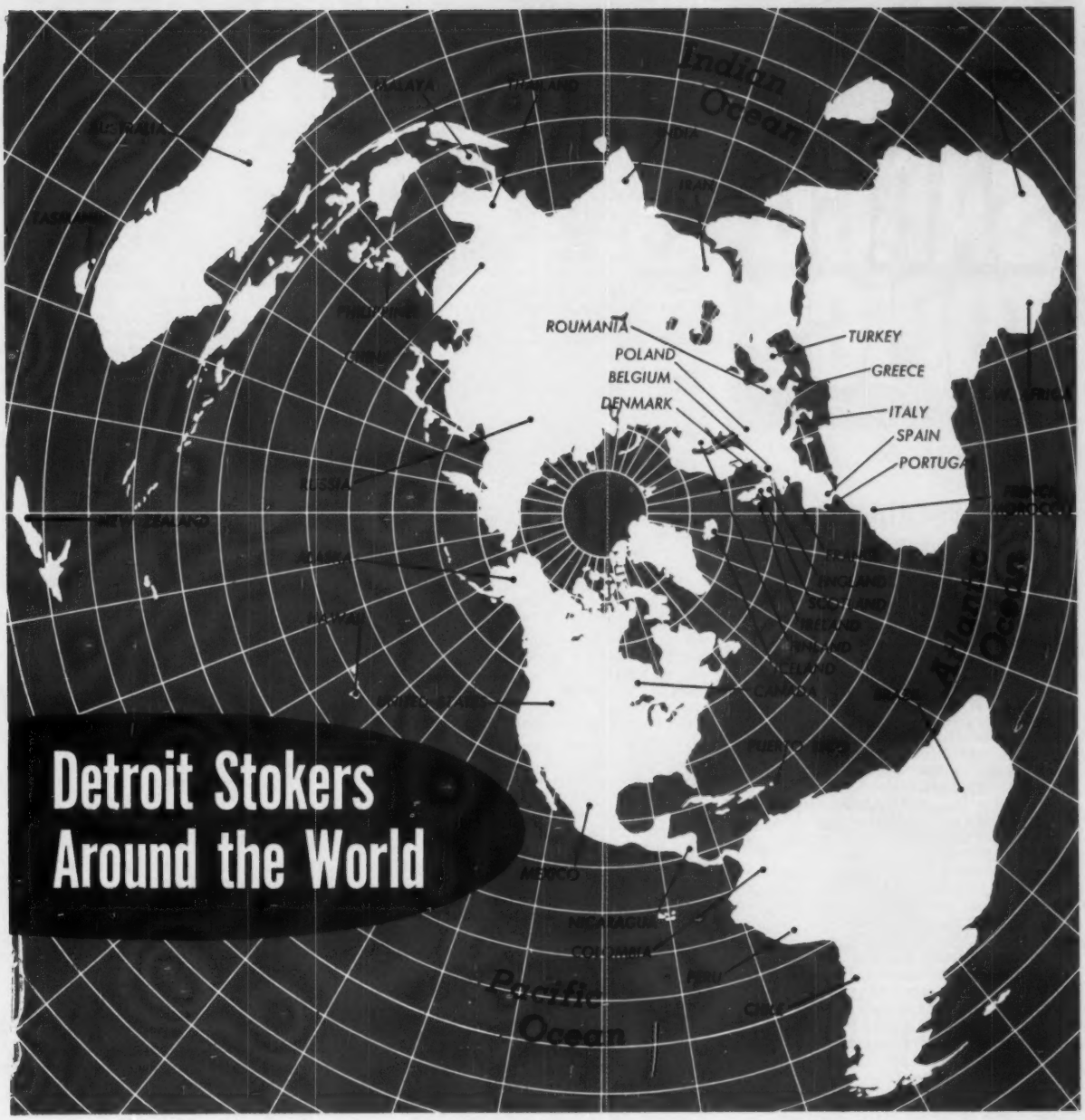
SOLUTION A Constant-Support Hanger balances the weight of a vertically shifting load in all positions throughout the travel range.

Grinnell maintains an experienced staff of technicians to discover better ways of solving pipe suspension problems, too.

Hanger load calculation booklet



Grinnell will be glad to send you — without obligation — a 32-page booklet, "Calculations for Hanger Loads and Thermal Movements". This helpful booklet furnishes necessary data and procedures to determine pipe hanger loads and thermal movements. Tabulations of piping weights and thermal expansion are arranged for convenient selection of data that usually takes considerable time to develop. Send for your copy *today*. Grinnell Company, Providence 1, R. I. Branch Warehouses in Principal Cities.



Detroit Stokers Around the World

Detroit Stokers satisfy industrial, institutional and heating needs on every continent of the earth.

Why this universal preference? One important reason. They are engineered for high efficiency, reliability and long life.

There are Detroit underfeed and overthrow spreader types for boiler capacities from 3,000 to 400,000 pounds of steam per hour and for all grades of bituminous coals, lignite and many by-product waste fuels.

Also special designs for municipal and industrial incinerators.

DETROIT SINCE 1898 STOKERS

DETROIT STOKER COMPANY

DIVISION OF UNITED INDUSTRIAL CORPORATION

MAIN OFFICE AND WORKS • MONROE, MICHIGAN

District Offices or Representatives in Principal Cities

For more facts circle 227 on Reader Service card, p 107

ONE OF A SERIES OF CHATS ABOUT THE CONSERVATION AND CONTROL OF HEAT

SARCO TOPICS

WHY THE BIG STRAIN?

It's tough to keep gases and liquids "clean" as they run through a pipe. They drag impurities along, which can make even plain water a trouble maker, let alone more sophisticated fluids. That's because water, as a liquid or steam, is intimately involved with vital equipment like steam traps, temperature regulators, or tools. Meters, burners, nozzles, and pumps, too.

By this time you must realize we're going to talk strainers, don't you? A good, stout subject, of interest to all who feel production belongs up and costs belong down. Sarco makes strainers for water and condensate, steam, oil, air, gas and other piped fluids . . . dozens of different sizes and types and ratings of strainers to match every application need. Even our line of plain and simple strainers is built for super service. These are pipeline strainers, types AT, BT, and CT, which are designed for 250, 250 and 600 psi non shock, respectively, and 475°, 450° and 750°F. temperature ratings. Standard screens are heavy-gauge, perforated brass or stainless steel. Sarco specializes in screens that can withstand abnormal pressure differentials created by accumulated sediment.

Next, Sarco's flanged strainers, type D. These come in larger sizes, right up to 12", and are available in standard or extra heavy types.

And finally, *Sarco scraper strainers*, manual or motorized. These are the really eye-popping models, and if you can't use one yourself — well — you'll just have to get your kicks elsewhere.

Examples? Take Inland Steel Company at East Chicago, which gets water from Lake Michigan to cool its large air conditioner condensers. The water used to pass through traveling screens, but still contained fine sand. Clogging!

Heat under collars! Frequent cleaning required! Sometimes practically no air conditioning on hot days. (Isn't that always the way?)

The Inland Steel people installed Sarco Rotary Scraper Strainers, Type VRS, which incorporate a hand-operated helical scraper knife within the cylindrical strainer screen. A few turns of the crank at regular intervals, and the sand is scraped off the screen, blown clear, and discharged at pressure through a manual valve to waste. Dismantle the strainer? Shut down the unit? Not *this* strainer!

Now, as long as we've come this far, it's only a hop and a skip to the Firestone Tire and Rubber Co. in Akron, Ohio, who also use water in tremendous quantities. They circulate it through tire presses and a cooling tower, and there's no nonsense about it. It *has* to be clean or damage to equipment could be downright catastrophic. When the plant

modernized and enlarged, Firestone replaced their 4" Sarco hand-operated scraper strainer, type VRS, with a larger Sarco 8" model. And while they were about it, they got the motor-operated type, for continuous cleaning.

When we say that companies like these want the insurance of a Sarco strainer, it sounds like advertisingese, but sometimes there just isn't any other way to put it. Sarco strainers *are* insurance at low cost on the operation of your high cost equipment. So when we ask if you have lumps in your pumps, or worries over your slurries, we're *serious*. We've heard everything in the straining line, so why not write us for literature and answers to those special problems you have.

A T-44 IS THE BEST POLICY

Sorry, but we can't leave the subject of insurance without bringing to your attention one of the best little insurance policies any company requiring cooling control could invest in. It's the *self-powered* Sarco T-44 Automatic Cooling Control. No compressed air or electricity is needed, but its advantages are best described in terms of three different plants of just one Sarco customer — Revere Copper and Brass, Inc.

Revere-Baltimore, Md., has cut water use 40 to 50% with T-44's. But in addition to former water waste, Revere had even more problems: possible wet air from uncontrolled cooling of compressor aftercoolers, plus sweating compressor cylinders; variations in viscosity of hydraulic oil and bearing oil; gas generator water waste; unreliability of manual shut-off of water supply when machines were down.

If your ears perk up in sympathy at mention of any of these problems, the results of Revere's cooling control program should bring you to full attention. One large compressor that had gulped 2400 gallons per hour now takes only 420 gallon sips. In addition all the problems itemized above were solved. T-44's are now used on their air compressors, gas generators, and hydraulic oil systems. At Revere-Riverside, Cal., water savings of 50% were experienced, and at Revere-Rome, N. Y., substantial savings were made too.

But after all, wasting water is only one way of wasting money, so let's go on to another matter of interest: the evils of manual control. When cooling water is controlled by hand the temptation to leave the valve nearly wide open is almost overpowering, in order to play it safe if the load varies. Result: overcooling, of course. And varying the flow runs the risk of undercooling. In either case, lowered process efficiency. Answer: The automatic Sarco T-44, which can't be tempted, is meticulously honest, unsentimental, and plain inhumanly practical when it comes to cooling control. You really ought to write for literature. T-44 is your best policy.

SPARE PARTS INSURANCE

As long as we're near the end, and still on this subject of insurance, may we graciously leave you with this valuable tip? No matter how closely a steam trap approaches perfection, some gremlin may cause it to act up. It's conceivable. So, keep on hand a parts list and spares of key parts for your steam traps and other system components. Parts are small and worth their weight in gold when you need them. A Sarco field engineer will make up a suggested list for you, if you tell us what components make up your system.

Might as well even keep a disc or two on hand for your Sarco Thermo-Dynamic Steam Traps, Type TD-50, even though they're so trouble-free our salesmen keep complaining about the lack of replacement parts business. We'll be glad to tell you about this unique steam trap in case you still don't know how miraculously simple and effective it is.

Pardon our monopolizing the conversation in this series of paid communiques, but we're trying our best to interest you in certain subjects that concern us both — to the point where you'll communicate.

5903

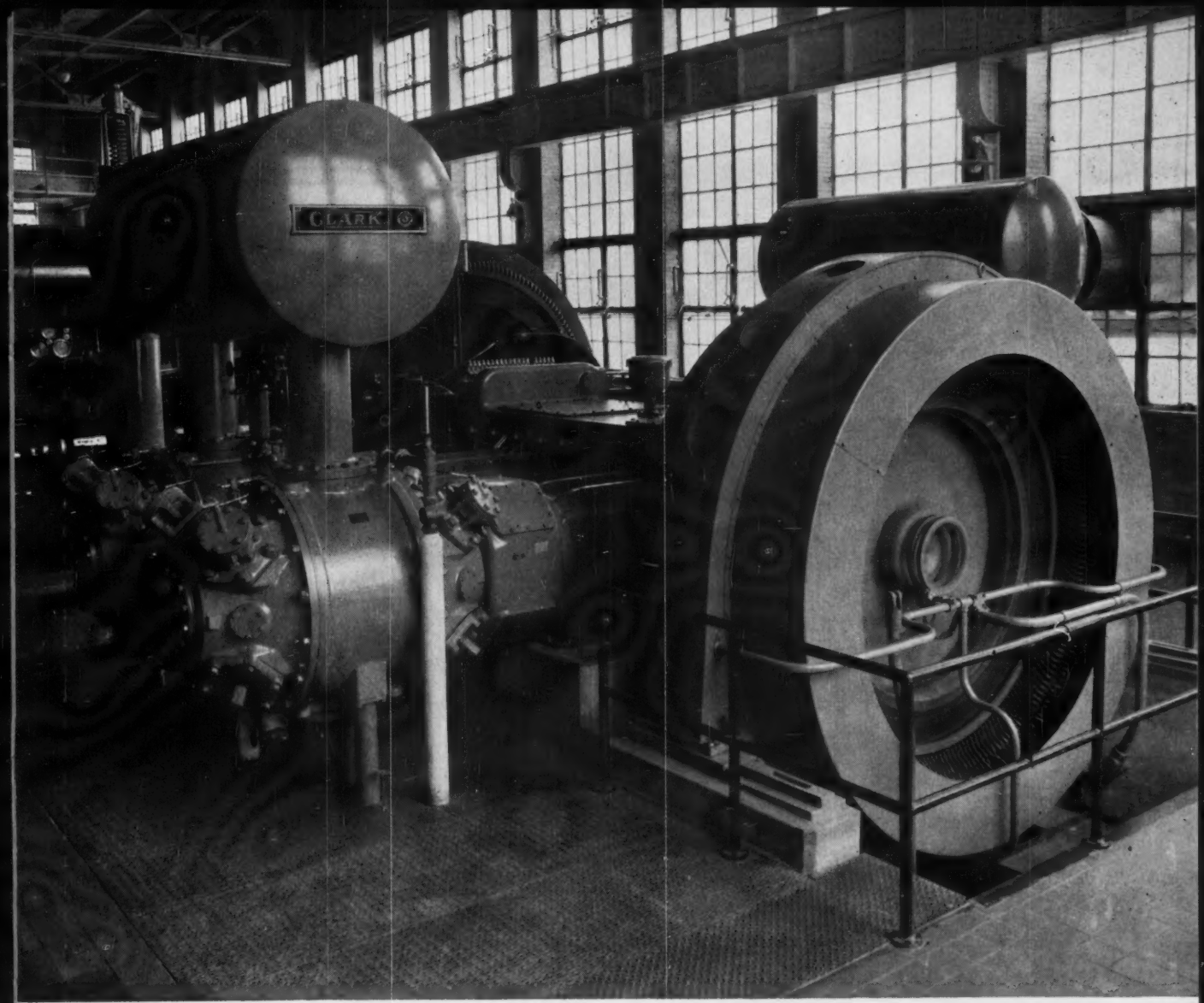
SARCO

SARCO COMPANY, INC.
635 MADISON AVENUE, NEW YORK 22, N. Y.
PLANT: BETHLEHEM, PA.

STEAM TRAPS • TEMPERATURE CONTROLLERS
STRAINERS • HEATING SPECIALTIES

For more facts circle 228 on Reader Service card, p 107

circle 229 on Reader Service card, p 107 ➤



Clark Air Compressor Keeps Lid On Maintenance!

Just Plain Dependable—That's the only way to describe this 2000 bhp Clark CBA-4 Balanced/Opposed Compressor. Ten years ago it was installed in the assembly plant of a major Detroit automotive manufacturer. To date, there has been no forced downtime other than scheduled maintenance overhauls.

On Duty 16 Hours a Day, five days a week, the compressor operates as a base load machine supplying 10,000 cfm of air at 105 psi. This is rated at 8% of total plant air utilized to operate the assembly line, paint shops, glass plant, blast furnaces and other functions.

Under a Preventive Maintenance Program, the compressor is overhauled once every two years. After 10 years of service, the valves are still original equipment. Bearings are also original equipment and have required no maintenance since startup.

Besides this Trouble-Free Performance, the user is on the "plus" side in many other respects. Among them: Smooth operation achieved by Clark Balanced/Opposed design; compactness that saves floorspace; simplified, reduced foundation requirements; inherent accessibility; marked simplicity of design.

Covering a Range of 75-8000 BHP, the Clark Balanced/Opposed, Motor-Driven line is increasingly becoming industry's preference for plant air requirements. Complete details are obtainable in Bulletin 185. Write now for your copy or get the facts first hand from your nearest Clark representative.

ROOTS CONNERSVILLE — Blowers, Compressors, Gas Pumps, Rootsmeters, Vacuum Blowers

Working together in allied industries . . .

PODBIELNIAK — Centrifugal Contactors, Distillation Apparatus, Instrumentation

CLARK

DRESSER INDUSTRIES INC.

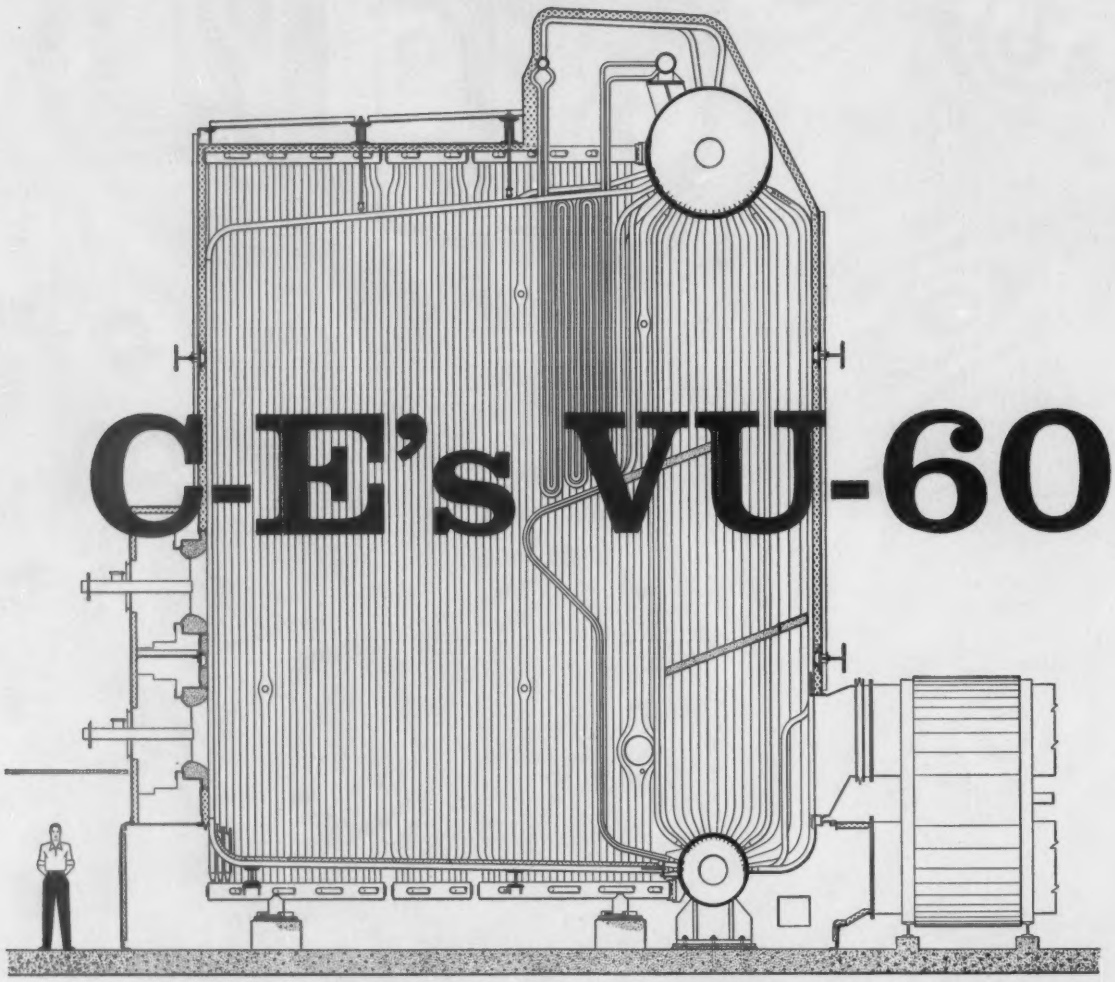
OIL • GAS • CHEMICAL
ELECTRONIC • INDUSTRIAL

CLARK BROS. CO.

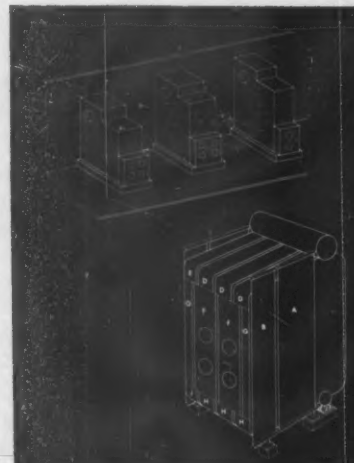
OLEAN, N. Y.

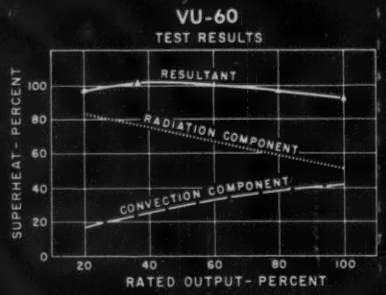
Engines • Compressors
Gas Turbines

C-E's VU-60



SOME DESIGN HIGHLIGHTS OF THE VU-60





Modular increments allow assembly of custom designs from standardized components; boiler can be proportioned for best combustion, heat absorption, gas flow — even where space conditions are difficult.

Completely self-cased, the VU-60 is an all-welded pressure-tight envelope composed of modular panels of finned tubes; fewer field welds cut erection time.

Insulation and preformed lagging go directly over tube panels, thus reducing non-working weight per pound of steam generated.

Characteristic of Combustion's VU-60. This superheater curve indicates a temperature stability throughout entire load range.

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS; PAPER

GIVES YOU A CUSTOM-DESIGNED BOILER BASED ON STANDARDIZED MODULAR COMPONENTS

Because of its unique modular concept, C-E's new VU-60 offers unusual flexibility and can be designed to meet unusual or difficult space conditions.

VU-60 SPECIFICATIONS

Capacities:	100,000 to 250,000 lb per hr
Design pressures:	250, 500, 750, 1040 psi
Steam temperatures:	to 900F
Fuels:	Oil and/or gas
Firing:	Horizontal (front wall) or tangential
Size increments:	Depth-twelve Width-eight Height-three
Steam drum sizes:	Four

The VU-60 is a completely self-cased boiler. Finned tubes, shop-welded into modular panels, make up the exterior walls of the unit. The fins joining the panels are field-welded to make a pressure-tight envelope. Insulation is applied directly over these walls and is covered by pre-formed, field-installed metal lagging. The need for bulky or heavy non-working structural members is kept to a minimum.

The VU-60 can be designed to meet your most exacting steam needs. It is easy to install, economical and dependable in operation, completely accessible and functional. Why not get full information on how this new concept can fulfill your specialized requirements?

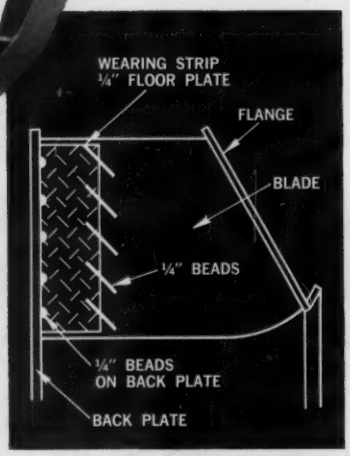
COMBUSTION C-E **ENGINEERING**

General Offices: Windsor, Conn., New York Offices: 200 Madison Avenue, New York 16, N. Y.
Canada: Combustion Engineering-Superheater Ltd.

C-322

MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

For more facts circle 230 on Reader Service card, p 107



Designed for the most rugged induced draft applications, 'Buffalo' Type "H" Fans withstand continuous abrasive wear at the highest static efficiency ever obtained with this type fan. ■ Radial tip blades curve smoothly forward at the heel to meet incoming air at the optimum angle. A modified flange design produces streamlined flow of air from wheel entrance to tips of the blades. Welded wear strips (¼" steel floor plate) break up particle flow and prevent dust particles from gouging or scouring the blades. ■ Particle buildup is eliminated... housing wear is negligible... turbulence is minimized. In addition, static pressure and capacity are increased... maintenance costs and sound levels lowered. ■ 'Buffalo' Type "H" Fans are available in 15 sizes and a variety of widths for various capacity/pressure requirements. ■ For all the facts, call the resident Buffalo representative nearest you. Or write our home office direct.

AIR HANDLING DIVISION

BUFFALO FORGE COMPANY

Buffalo, New York

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

'Buffalo' Air Handling Equipment to move, heat, cool, dehumidify and clean air and other gases.

'Buffalo' Machine Tools to drill, punch, shear, bend, slit, notch and cope for production or plant maintenance.

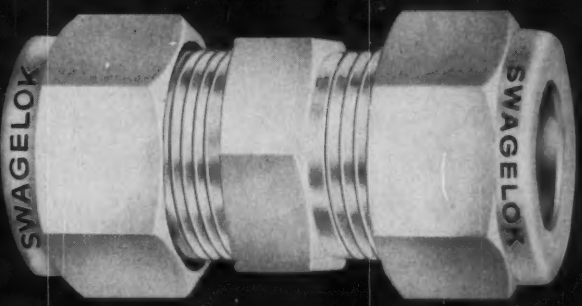
'Buffalo' Centrifugal Pumps to handle most liquids and slurries under a variety of conditions.

Squier Machinery to process sugar cane, coffee and rice. Special processing machinery for chemicals.

For more facts circle 231 on Reader Service card, p 107

circle 232 on Reader Service card, p 107 ➤

WHY WAS THIS TUBE FITTING MADE FROM PLATINUM?



This Swagelok tube fitting was machined from Platinum because that is what our customer needed for his nuclear reactor experiments. This is just one of many outstanding examples of Swagelok customer service. The scientist who needed this fitting knew that Swagelok tube fitting reliability would meet the exacting requirements of leak tightness for nuclear work. He also knew that full cooperation in delivering Swagelok in any machineable metal is routine.

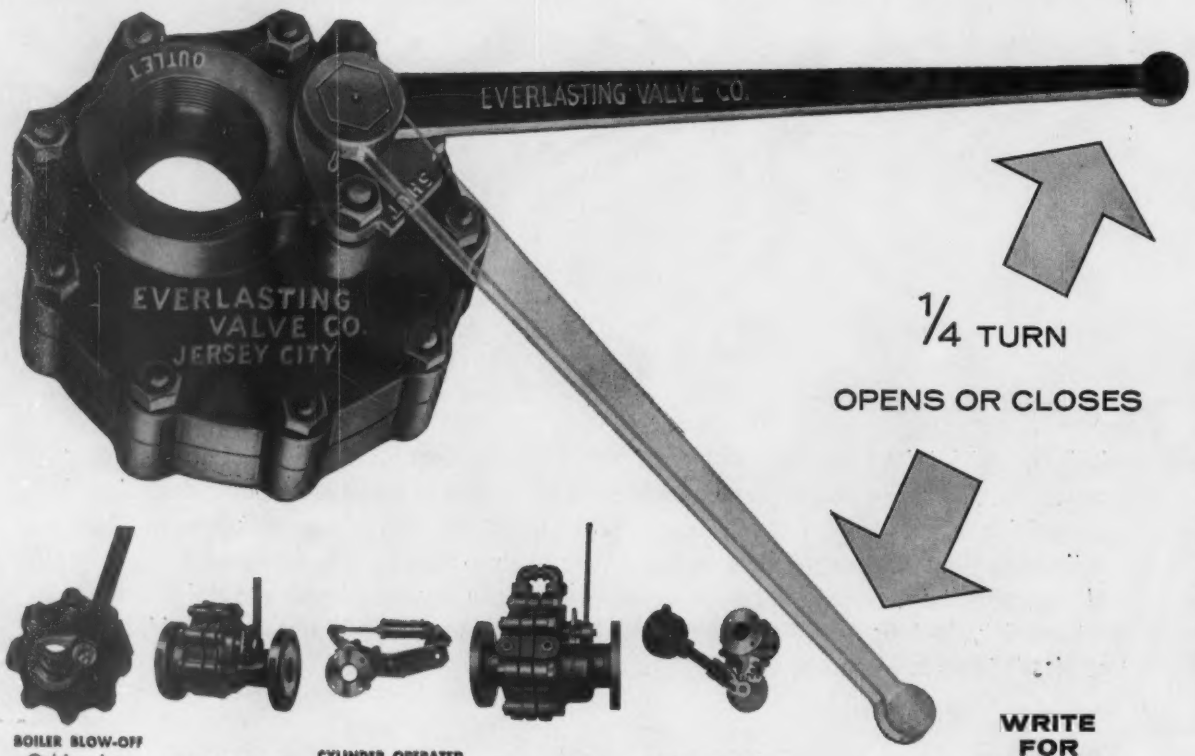
Swagelok, the tube fitting of total dependability, can be provided in **any** machineable metal or plastic to solve your most demanding problem.

Swagelok® TUBE FITTINGS SOLVE YOUR PROBLEMS

CRAWFORD FITTING COMPANY • 884 EAST 140th St. • CLEVELAND 10, OHIO
CRAWFORD FITTINGS (CANADA), LTD. • NIAGARA FALLS, ONTARIO, CANADA

When you need fast, easy opening and closing with a leak-proof seal and straight-through flow with minimum pressure drop specify

EVERLASTING



BOILER BLOW-OFF
Quick acting, also handwheel operated "Y" and angle types. For pressures up to 600 psi.

GENERAL SERVICE
Where drop-tight seal and full flow is essential.

CYLINDER OPERATED
Can be remotely controlled, electrically or manually.

STEAM JACKETED
Assures free flow of viscous materials.

WEIGHT-OPERATED
For automatic drains or emergency shut off.

WRITE FOR BULLETIN

EV-409

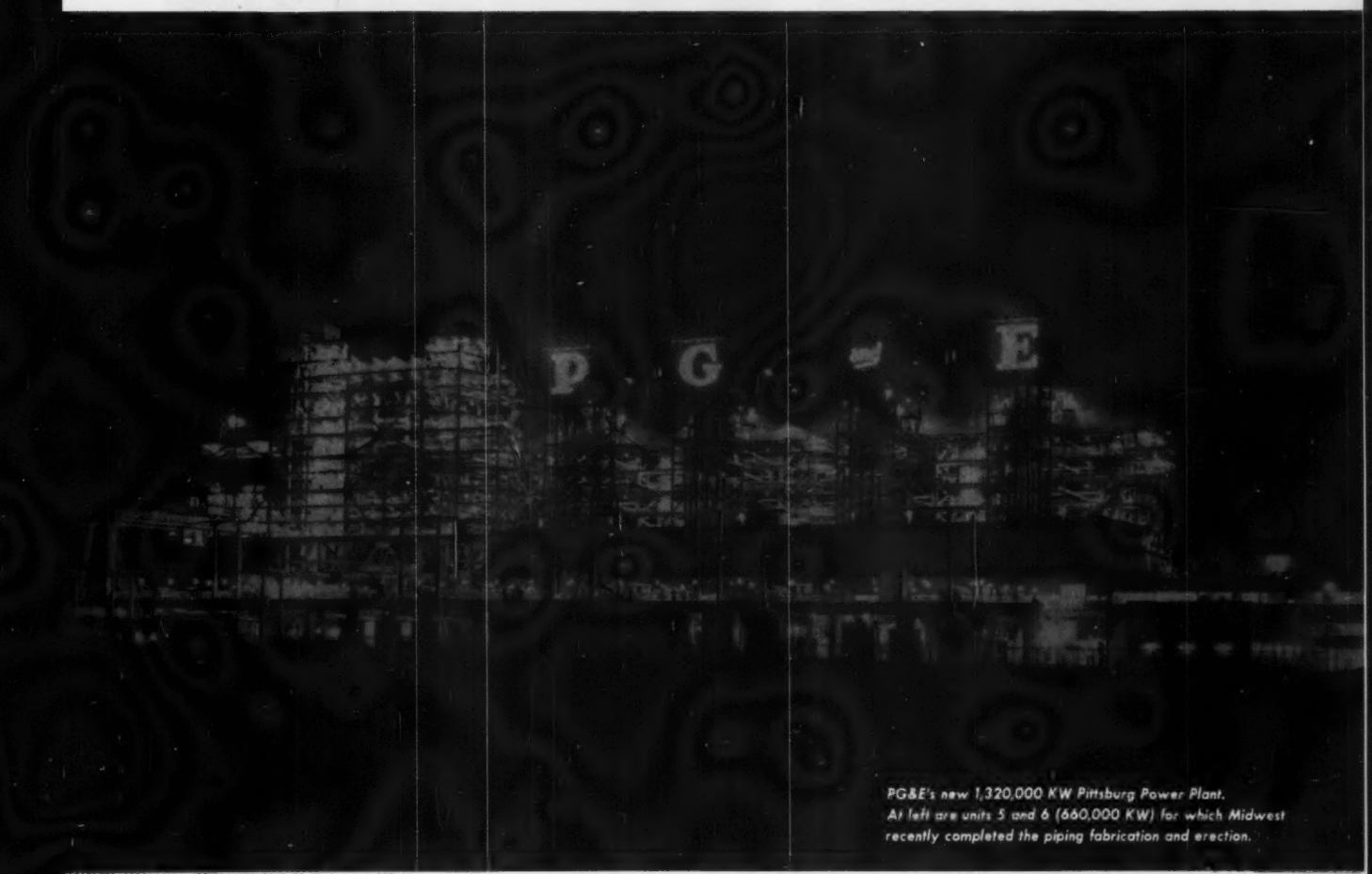
EVERLASTING VALVE COMPANY, 45 **FISK STREET, JERSEY CITY 5, N.J.**

For more facts circle 233 on Reader Service card, p 107

NEW PG&E UNITS PIPED BY MIDWEST

Pacific Gas and Electric Company, serving the rapidly growing region of Northern and Central California, has added 3,615,500 KW of steam plant capacity since World War II alone. Another 720,000 KW is scheduled for completion by mid-1963. Midwest is proud to have been the piping fabricator and/or erector for most of the new or expanded plant capacity completed to date or under contract, and to have been selected as the fabricator and erector for PG&E's newest project—units 3 and 4 at Morro Bay Station. In all, PG&E will have 26 generating units in 7 plants benefiting from power piping by Midwest!

For an illustrated booklet on Midwest's capabilities in piping, write for Bulletin 60B, POWER AND PROCESS PIPING.



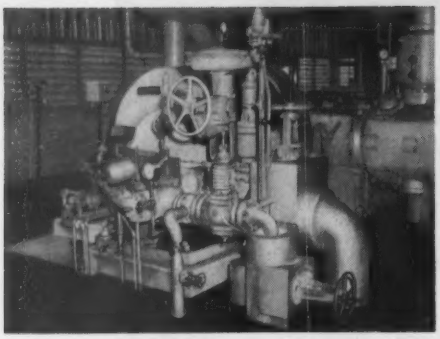
PG&E's new 1,320,000 KW Pittsburg Power Plant. At left are units 5 and 6 (660,000 KW) for which Midwest recently completed the piping fabrication and erection.

Division of Crane Co. / *1450 South Second Street, St. Louis 4, Missouri*

MIDWEST PIPING

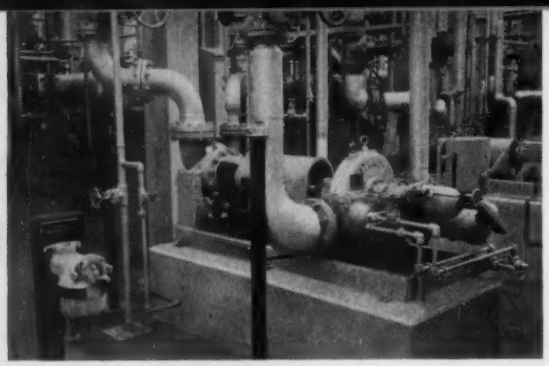
For more facts circle 234 on Reader Service card, p 107

6144

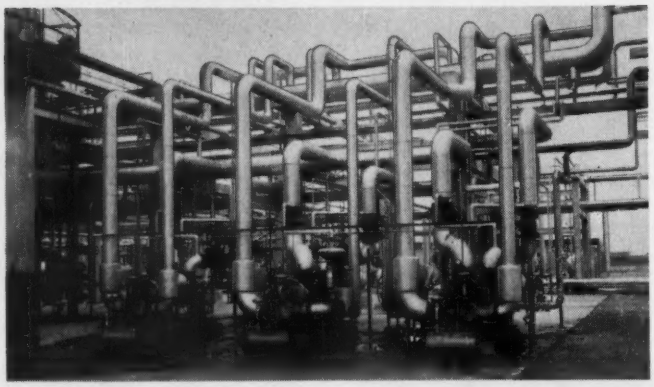


600-hp Elliott turbine driving a compressor which supplies compressed air for process.

(Right) Elliott steam turbines power many reflux pumps throughout the refinery. Shown here are three, driving gasoline column bottoms pumps in the crude unit.

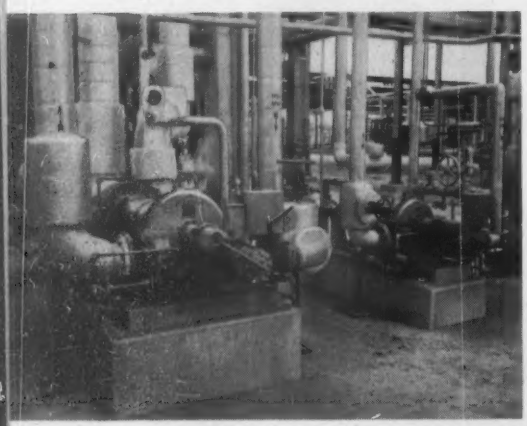


The YR turbine shown above drives an oil pump in the alkylation plant.

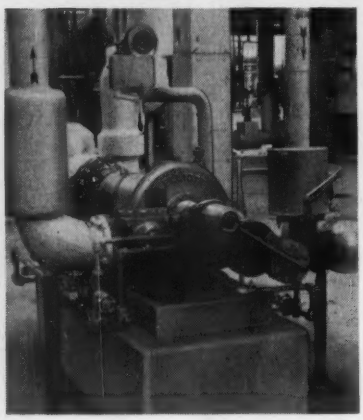


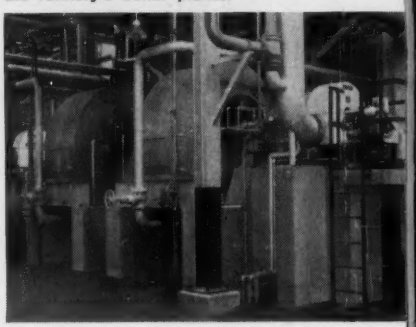
The turbine-driven condensate pump shown below charges foul condensate to stripper column.

Below are forced-draft fans driven by Elliott turbine-gear units in one of the refinery's boiler plants.



The unit on the left above is a condensate pump, and the one on the right is a seal oil and flushing oil pump. Both are driven by Elliott turbines.





FROM TURBINE HEADQUARTERS

In one refinery, 85 Elliott turbines driving pumps, compressors, fans prove Elliott versatility

Ranging in size from 5 to 935 horsepower, these Elliott YR single stage turbines are installed in a giant East Coast Refinery. The units were selected from a modern, field-proven line of mechanical drive turbines rated up to 50,000 horsepower.

Installations like this together with experience of more than 50 years in turbine design, manufacture and application are among the reasons why Elliott is truly "Turbine Headquarters." Write for descriptive bulletin H22-D. H1-2

day-in/day-out

ELLIOTT COMPANY

GENERAL OFFICES: JEANNETTE, PENNSYLVANIA PLANTS AT: Jeannette and Ridgway, Pa.; Springfield, Ohio

TURBINES · GENERATORS · MOTORS · COMPRESSORS · TURBOCHARGERS · EJECTORS · STRAINERS · TUBE CLEANERS

For more facts circle 235 on Reader Service card, p 107

Announcing 2 New RIGID CONDUIT BENDERS

EXTRA-DEEP SOCKETS MINIMIZE HANDLE BREAKAGE!

Cast of high-strength malleable, these new RIGID Conduit Benders have an exceptionally smooth, typically RIGID quality finish you'll like on sight. Look in the extra deep sockets, and you'll see the threads down at the bottom. Elimination of strain on threads of pipe handle reduces breakage.

RIGID Thin-Wall Conduit Benders Available in 3 Sizes

B-1677 Bends ½" Thin-Wall Conduit to 4" Inside Radius
B-1678 Bends ¾" Thin-Wall and ½" Heavy-Wall Conduit to 5" Inside Radius
B-1679 Bends 1" Thin-Wall and ¾" Heavy-Wall Conduit to 6½" Inside Radius

Exceptionally smooth side-walls hug conduit snugly . . . minimize distortion. Benders form conduit to meet National Electric Code Standards. Steadying foot pressure is easily applied on non-slip step plate. Easy-to-see arrows give accurate guide for back-to-back and stub bends.

RIGID Hickey-Type, Heavy-Wall Conduit Benders

B-1711 Bends ½" and ¾" Heavy-Wall Conduit
B-1712 Bends ¾", 1" and 1¼" Heavy-Wall Conduit

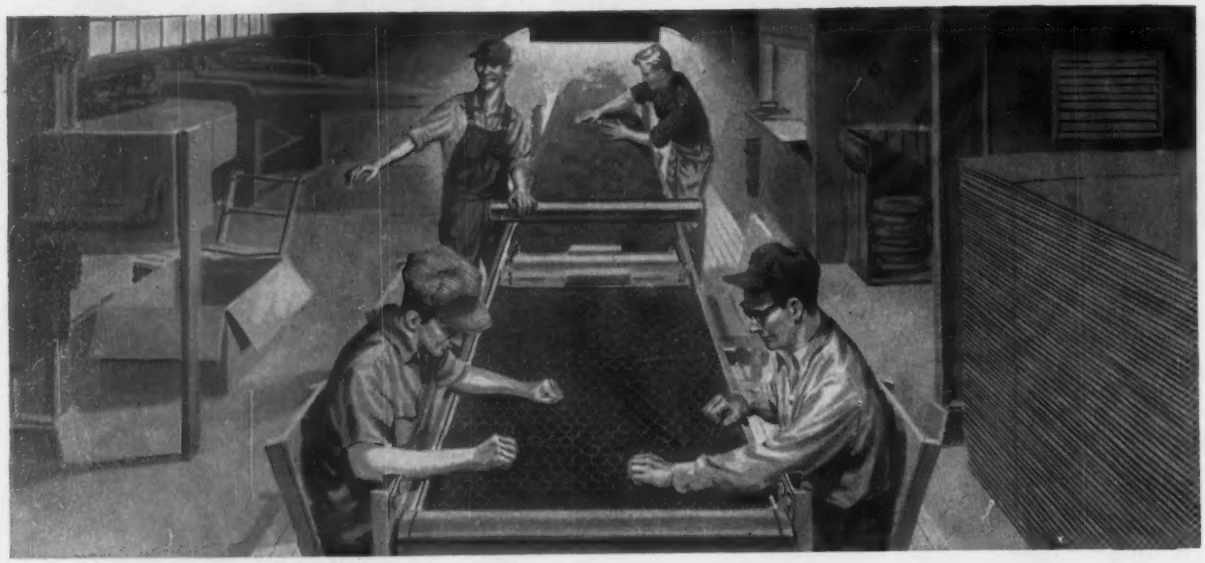
Here's a rugged bender for heavy-wall conduit. Deep notch in lifting hook protects threaded ends. Face of bender has hardened teeth for safe, long wearing, non-slip grip.

RIGID

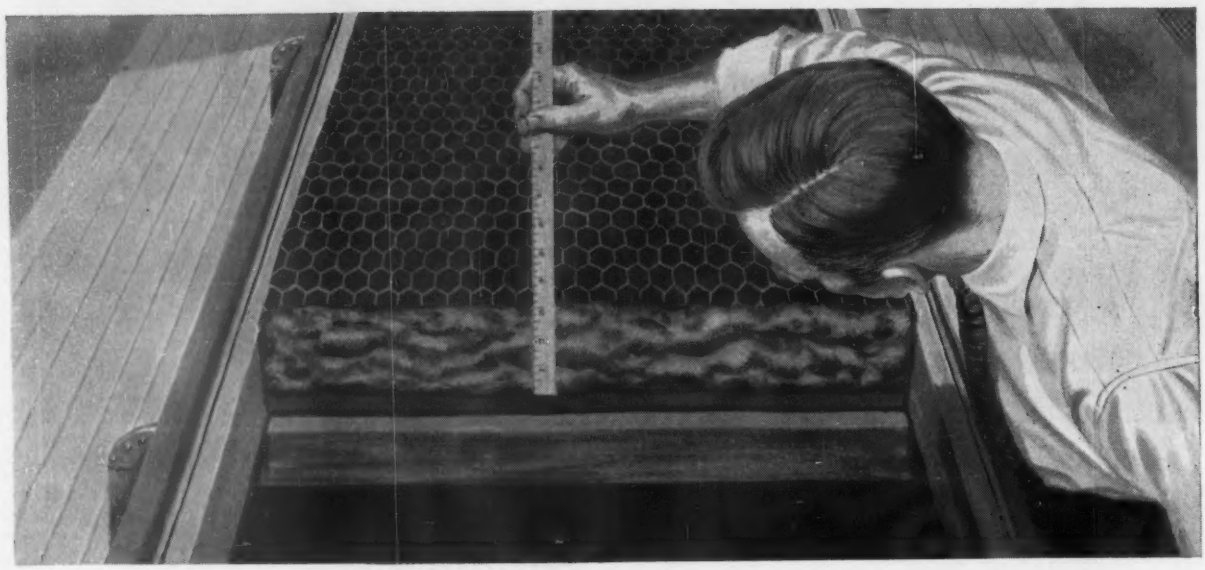
Call your Distributor today. For your convenience, he maintains a complete stock of RIGID Work-Saver Pipe Tools and parts!

THE RIDGE TOOL COMPANY, ELYRIA, OHIO, U.S.A.

For more facts circle 236 on Reader Service card, p 107



FACTORY FABRICATED TO RIGID SPECIFICATIONS!



Don't risk efficiency with careless, made-on-the-job blankets.

- Copper bearing steel laths, bound by uniformly spaced soft-drawn galvanized tie wires, keep blankets firm but flexible.
- Eagle-Picher mineral wool evenly dispersed over entire insulating area of each blanket.
- Completely free of large voids usually found in field-made blankets where insulation is haphazardly packed in place.
- Smooth edges butted tightly together eliminate cracks and loose joints.
- Quickly applied to flat or slightly curved surfaces of any large equipment—or cut to fit irregular areas.
- Maximum thermal efficiency at temperatures as high as 1200 F.

Eagle-Picher produces a complete line of industrial insulations for all temperatures from below Zero to over 2000 F.

EAGLE-PICHER BLANKET INSULATION

This Mineral Wool Insulation conforms to COMMERCIAL STANDARD CS-117-49 as issued by U.S. DEPARTMENT of COMMERCE.

EAGLE-PICHER / Manufacturer's Manufacturer

Since 1843 / The Eagle-Picher Company
Dept. P-77
Cincinnati 1, Ohio

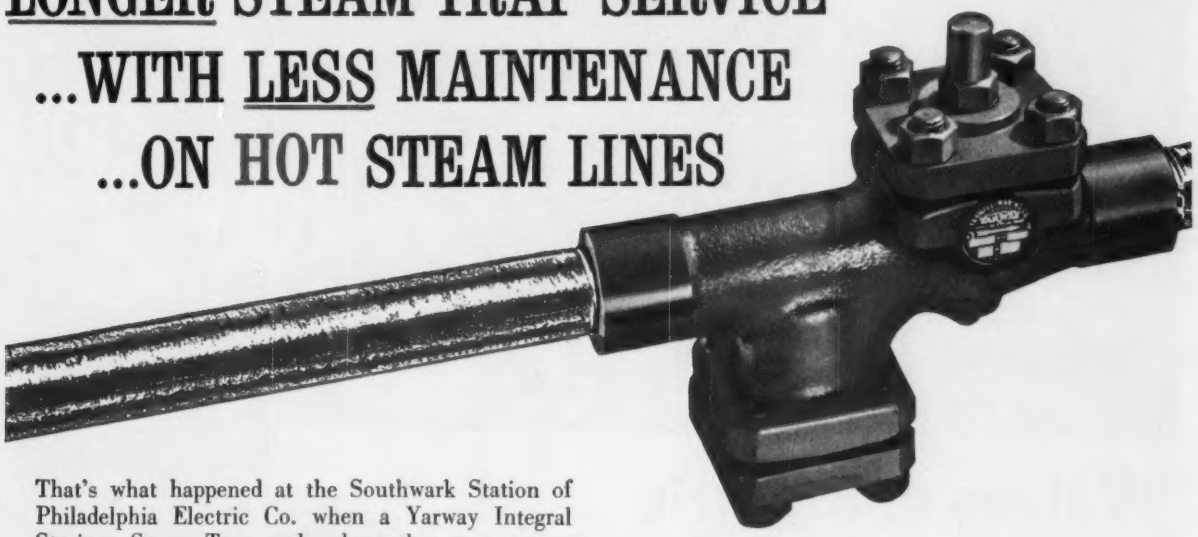
EAGLE EP PICHER

YARWAY news briefs

from **Yarnall-Waring Company,** *Philadelphia 18, Pa.*

BRANCH OFFICES IN 19 UNITED STATES CITIES • SALES REPRESENTATIVES THROUGHOUT THE WORLD
STEAM TRAPS STOCKED AND SOLD BY 270 LOCAL INDUSTRIAL DISTRIBUTORS

LONGER STEAM TRAP SERVICE ...WITH LESS MAINTENANCE ...ON HOT STEAM LINES



That's what happened at the Southwark Station of Philadelphia Electric Co. when a Yarway Integral Strainer Steam Trap replaced another trap on an attemperator coil installation.

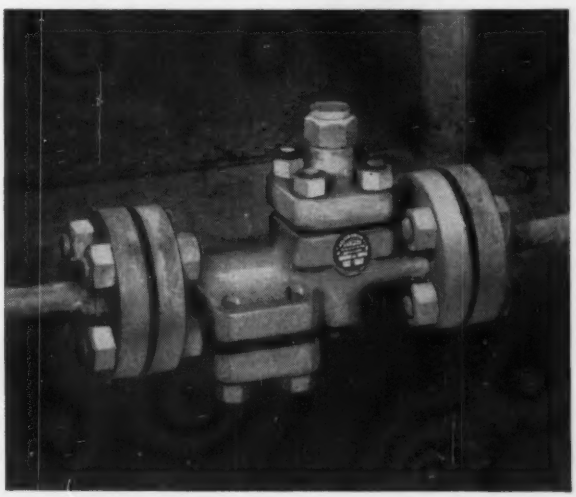
Operating pressure was 850 psi; temperature, 900° F. Other steam traps failed to operate longer than 4-6 months, and even that involved considerable maintenance. The first Yarway installed has operated *trouble-free* for over 10 months . . . is still going strong. Additional Yarway Integral Strainer Traps, installed on similar service, are performing just as well.

Utilities and other high pressure plants all over the country know and use Yarway Integral Strainer Traps for these reasons:

- Ample condensate capacity when system is being warmed-up—but also will handle small amounts of high temperature condensate without losing prime.
- Trap valve closes positively in presence of dry or superheated steam.
- Small size—rugged design.
- Built-in strainer with stainless steel woven wire screen and protective casing.
- Flanged or socket-welding ends available.

Consider these Yarway advantages for the "hot" lines in *your* plant. Write for full information on Yarway Integral Strainer Steam Traps.

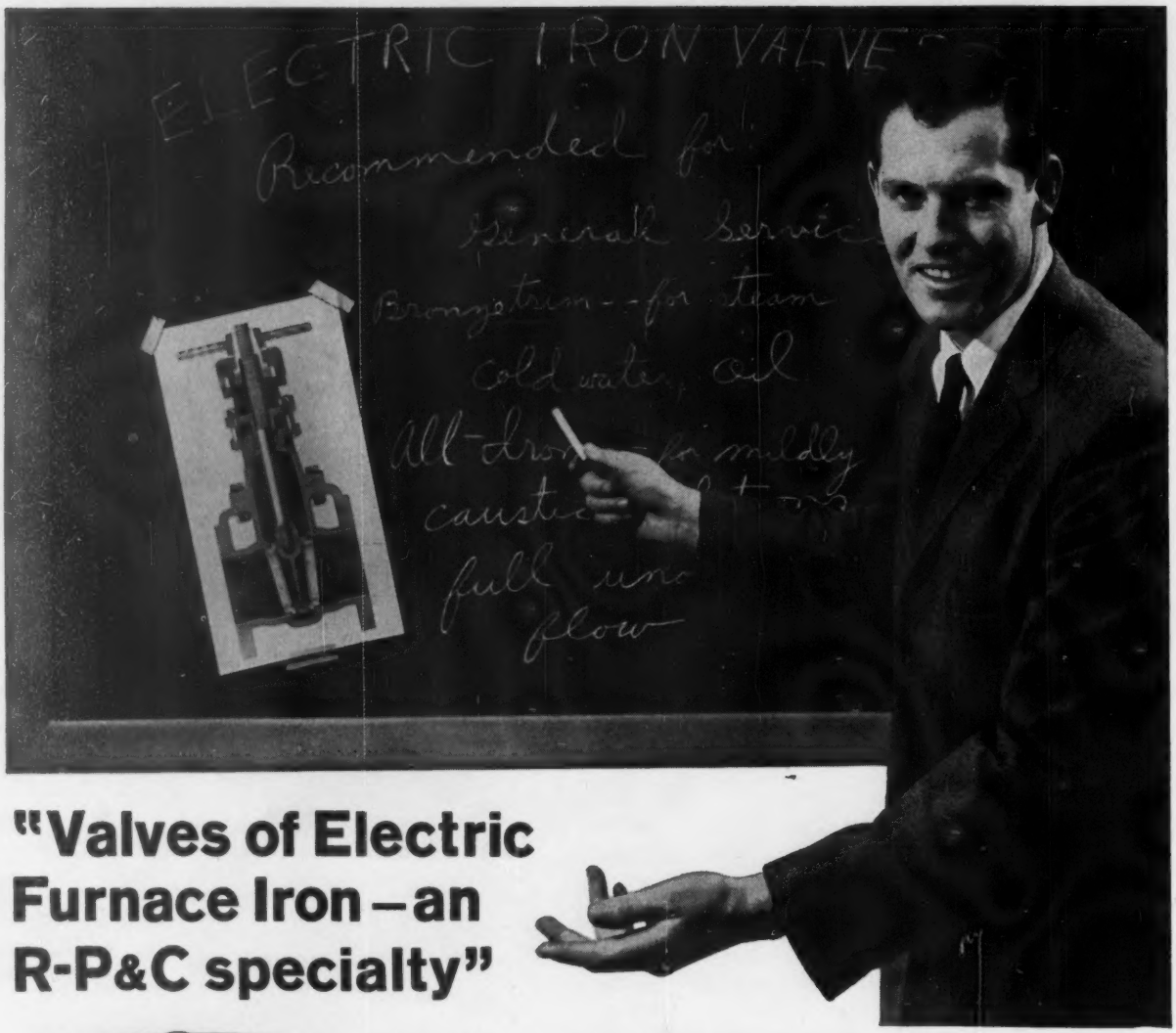
Yarway Integral Strainer Impulse Steam Trap (flanged design) on attemperator coil at Southwark Station of Philadelphia Electric Co. Operating pressure 850 psi, temperature 900° F.



OTHER YARWAY IMPULSE STEAM TRAPS FOR SPECIFIC OPERATING CONDITIONS

AVERAGE CONDENSATE LOADS	EXTRA HEAVY CONDENSATE LOADS	LIGHT TO MODERATE LOADS	
Series 60 and 120	Series 40	Series 30	Series 130

For more facts circle 238 on Reader Service card, p 107



"Valves of Electric Furnace Iron—an R-P&C specialty"

"Manufacturing castings from iron melted in our own electric furnaces and to our own specifications has long been an R-P&C specialty. Recognized for their superior quality, these castings of **highly refined metal** are substantially free of impurities. Dense grain structure gives them a high resistance to corrosion, high tensile and transverse strength, plus excellent deflection characteristics. In fact, their **physical properties far exceed** the standard requirements for iron valve castings. And all of these advantages are available to you in R-P&C Electric Furnace Iron Valves at no extra cost."

Shown here is an R-P&C Gate Valve of the flanged end type. It is available in sizes from 2" to 24" in bronze trim or all-iron construction. The R-P&C Iron Valve line includes other popular types of Gate, Globe, Angle and Swing Check Valves—all made of Electric Furnace Iron.

Contact your R-P&C distributor. He can supply you promptly with any Iron Valve you need as well as gate, globe, angle and check valves in bronze, cast steel and forged steel; all in a wide range of sizes, styles and pressure classes. See him or write...

R-P&C VALVES

ACCO

R-P&C Valve Division, American Chain & Cable Company, Inc.

Reading, Pa., Atlanta, Boston, Chicago, Denver, Detroit, Houston, New York, Philadelphia, Pittsburgh, San Francisco, Bridgeport, Conn.

For more facts circle 239 on Reader Service card, p 107

To function at optimum efficiency and thereby provide the lowest possible steam costs, central power stations must burn coals that deliver a uniformly high heat content.

Valley Camp Quality Coals are famous for meeting the requirements of central power stations. They are completely prepared and thermally dried under exact quality controls, ready for shipment in sizes and consist to specification.

Our combustion engineering service is available to analyze your problem, to help you get optimum efficiency with Valley Camp Quality Coals.

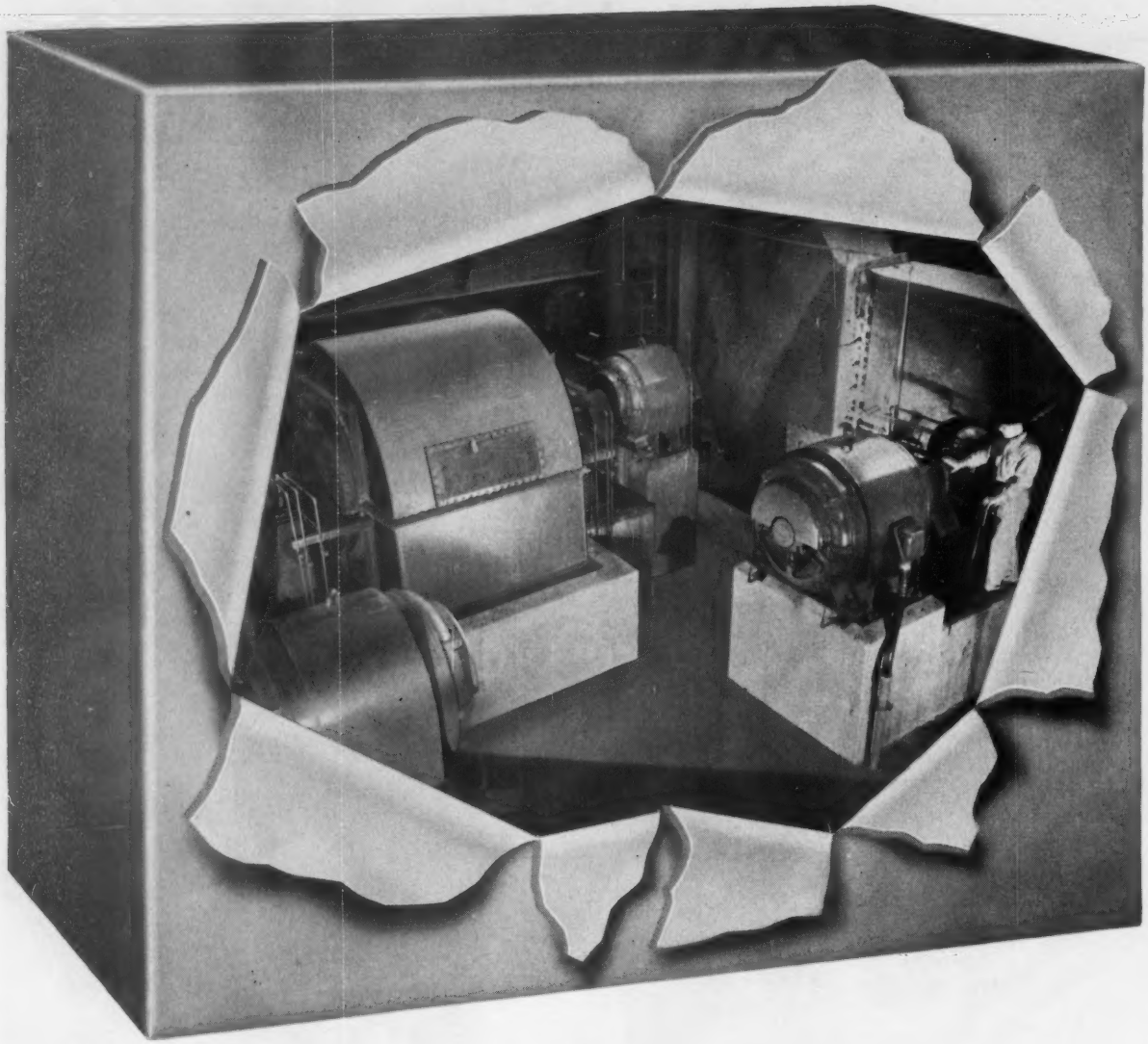
THE VALLEY CAMP COAL COMPANY

Western Reserve Building • Cleveland 13, Ohio

SUBSIDIARIES —
Great Lakes Coal & Dock Co., Milwaukee, Wis. • Great Lakes Coal & Dock Co., St. Paul, Minn. • Fort William Coal Dock Co., Ltd., Fort William, Ont. • The Valley Camp Coal Co. of Canada Ltd., Toronto, Ont. • Kelley's Creek & Northwestern Railroad Co. • Kelley's Creek Barge Line Inc. • Pennsylvania & West Virginia Supply Corp.

SALES OFFICES —
Philadelphia • Baltimore • Buffalo • Pittsburgh • Wheeling • Cleveland • St. Paul • Cincinnati • New York • Milwaukee • Superior, Wis. • Fort William, Ont. • Toronto, Ont.

For more facts circle 240 on Reader Service card, p 107



More power to ALTON BOX BOARD

. . . with the help of CLARAGE

Mechanical draft is among several assignments of Clarage equipment at Alton Box Board Co., Alton, Illinois.

On the left above in the power plant, a Clarage Type W, Class III double inlet fan equipped with Vortex Control provides forced draft . . . on the right is one of the two Clarage Type RT double inlet fans furnishing induced draft.

Investigate the advantages dependable Clarage equipment offers for YOUR mechanical draft installation. Contact our nearest sales engineering office or write us for complete literature.

Dependable equipment for making air your servant

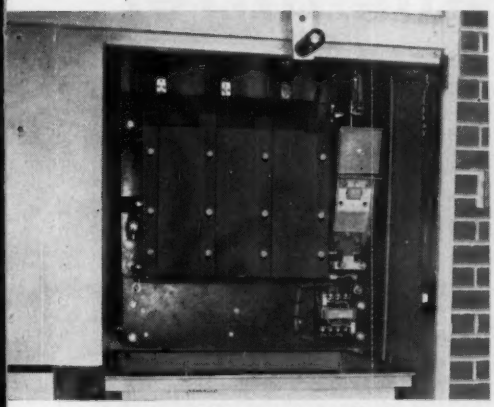
CLARAGE FAN COMPANY

Kalamazoo, Michigan

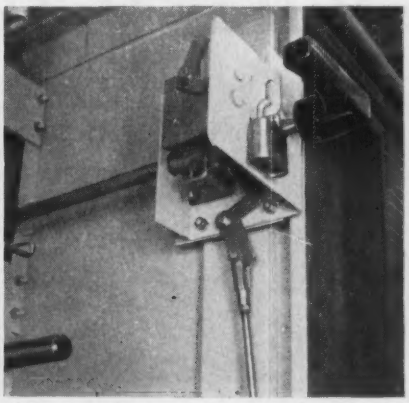
SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES • IN CANADA: Canada Fans, Ltd., 4285 Richelieu St., Montreal

NEW MEDIUM-VOLTAGE STARTERS FOR SEMI-HAZARDOUS DUTY

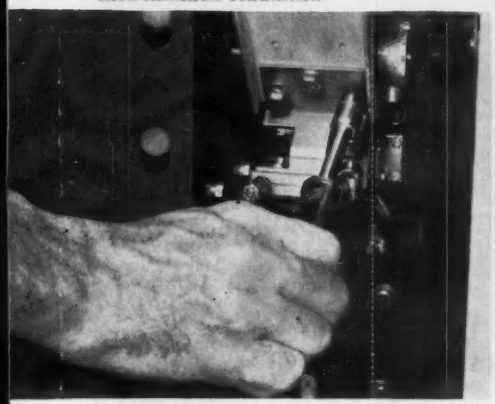
OIL-IMMERSED LIMITAMP* CONTROL



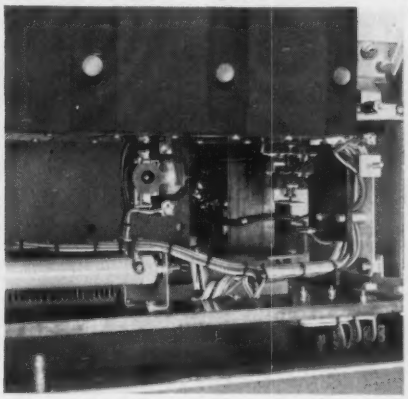
400-amp, oil-blast contactor has interrupting capacity of 50,000 kva for reliable operation and equipment protection in all environmental conditions.



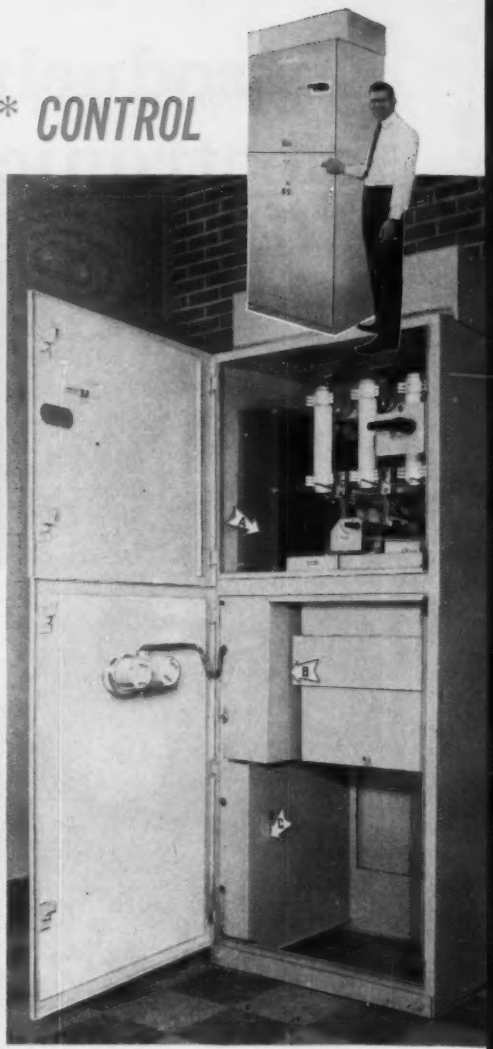
Advance-design interlocking prevents opening of isolating switch if contactor is closed; denies entrance to high-voltage compartment when panel is energized.



All maintenance and inspection of contactor and control components can be done with oil-blast tank lowered. Control is front connected for accessibility.



Oil-immersed control-power interlock in primary circuit of the control-power transformer assures that no current is broken when the isolating switch is opened.



Isolation barrier system (A, B, and C) segregates high-voltage points for installation of motor cables when bus is energized and isolating switch is open.

NOW safer operation, superior protection with new General Electric Limitamp Control

Safer operation plus maximum equipment protection are yours when you specify new General Electric Oil-immersed Limitamp control . . . the medium-voltage motor starter for use in semi-hazardous and corrosive environments, as well as in many general-purpose applications throughout industry.

Positive equipment protection is inherent in the design of General Electric Oil-immersed Limitamp control. Current-limiting fuses interrupt faults within the first half cycle, before damage occurs. The 50,000-kva oil-blast contactor rapidly interrupts motor current during all overload conditions. Control components are oil-immersed for long life and maximum protection against contaminants.

General Electric's Oil-immersed Limitamp control employs industry's most advanced interlocking system for **operating and maintenance personnel safety.** The isolating-switch handle and high-voltage compartment door are mechanically and electrically interlocked with the contactor. Only when the isolating-switch handle is in the "Open" position can personnel enter the high-voltage compartment.

For full information on new Oil-immersed Limitamp control—for motors rated up to 1500 hp at 2300 volts, and 3000 hp at 4600 volts—contact your G-E Sales Engineer or Agent. Or, write Section 783-18, General Electric Co., Schenectady, N. Y., for Bulletin GEA-7236. ***Industry Control Department, Salem, Va.***

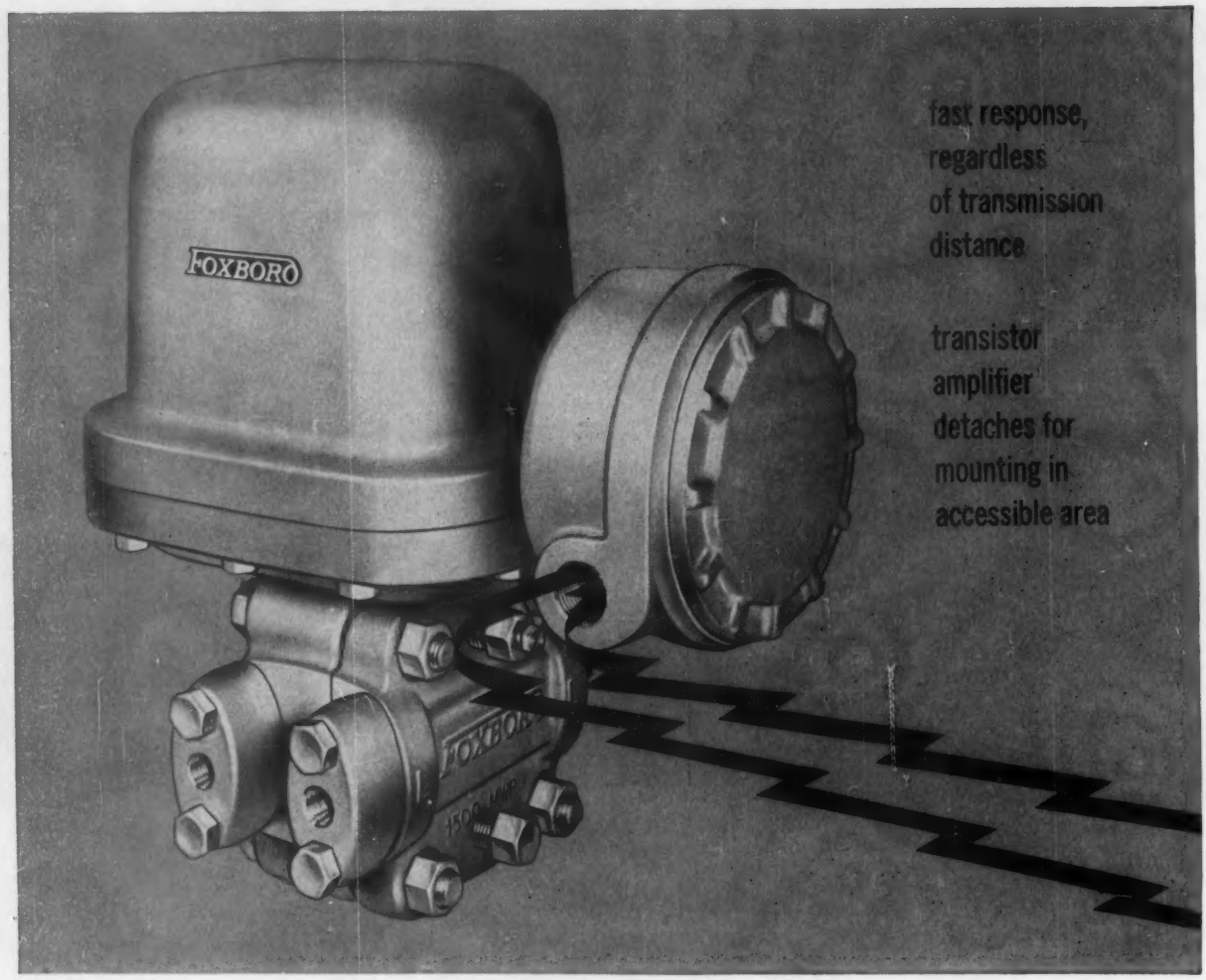
*Reg. Trade-mark of General Electric Company.

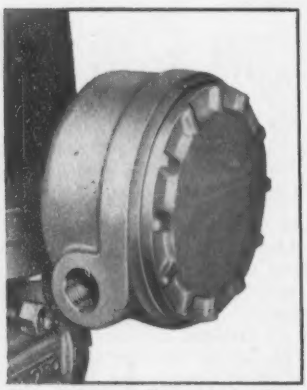
Progress Is Our Most Important Product

GENERAL ELECTRIC

For more facts circle 242 on Reader Service card, p 107

introducing the Foxboro electronic d/p cell* transmitter


FOXBORO
fast response, regardless of transmission distance
transistor amplifier detaches for mounting in accessible area



Transistor amplifier of the Foxboro Electronic d/p Cell can be detached for relocation in an accessible area, so that all transistors are removed from possible contamination. Separate mounting has absolutely no effect on accurate measurement and transmission.

Yes, Foxboro has taken its famous pneumatic d/p cell transmitter and added to it the benefits of electronic transmission. Look at the results:

- true force-balance design for lowest displacement — fastest response
- solid state throughout — no vacuum tubes to replace
- pressure, flow, and level transmission up to several miles without lag
- same body, same performance as thousands of pneumatic d/p cells now in operation
- ranges from 5 to 850″ of water — maximum working pressures to 6000 psi

And then, of course, you get the same positive overrange protection, the same high sustained accuracy, the same rugged construction that has always been standard with the Foxboro d/p cell transmitter.

Foxboro electronic d/p Cells are presently in use measuring and transmitting: pressurizer level, primary coolant flow, and steam generator 3-element feed-water level and flow. For full details on this important unit in the Foxboro Electronic Consotrol* family, get in touch with your Foxboro Field Engineer. Or write for Bulletin 21-10. The Foxboro Company, 688 Neponset Avenue, Foxboro, Mass.

Reg. U. S. Pat. Off.

FOXBORO
REG. U.S. PAT. OFF.

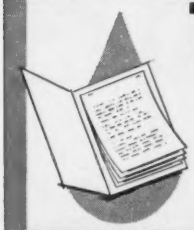
For more facts circle 243 on Reader Service card, p 107

NEED WATER TREATMENT?

BE WISE...

MOGUL-IZE*

WITH MOGUL QUALITY PRODUCTS AND MOGUL SERVICE



1. COMPLETE SURVEY

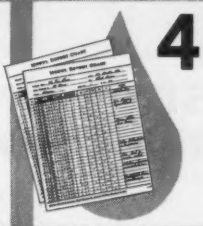
Your Mogul Service Man will survey all equipment requiring treatment. Our Service Department will review this survey and make treatment recommendations.

2. CONSULTATION

Our Service Department is available for water problem consultation at all times. Water samples will be analyzed and results reported to you at No Charge.

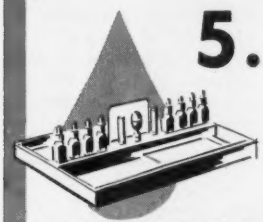
3. WATER TESTS

Your Mogul Service Man will make water tests whenever necessary. Our Service Department will provide instructions for blowdowns, wash-outs and standby procedure, as required.



4. REPORT CHARTS

Mogul Report Charts are supplied so you may keep daily records of your water control tests. Monthly charts may be submitted for Service Department review and comments.



5. TEST SET

We furnish you with a Mogul Test Set. TEST SET REAGENTS ARE SUPPLIED AT NO CHARGE.

6. PERIODIC CALLS

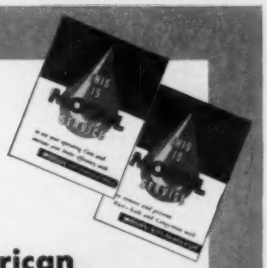
Your Mogul Service Man will assist your operating personnel in the use of Mogul products, and proper feeder requirements.

When you MOGUL-IZE your operating equipment with Mogul Quality Products and Mogul Service you are assured of receiving protection from the damaging effects of water.

MOGUL offers a completely integrated water treatment program with performance results "guaranteed and backed by a bond".

MOGUL-IZING is the answer to more efficient operation of your equipment through "personalized" treatment of your specific water problems.

Write today for more complete information. It's Wise to MOGUL-IZE! Let your Mogul Service Man show you why. There is no obligation.



Product literature is available on request.

The North American

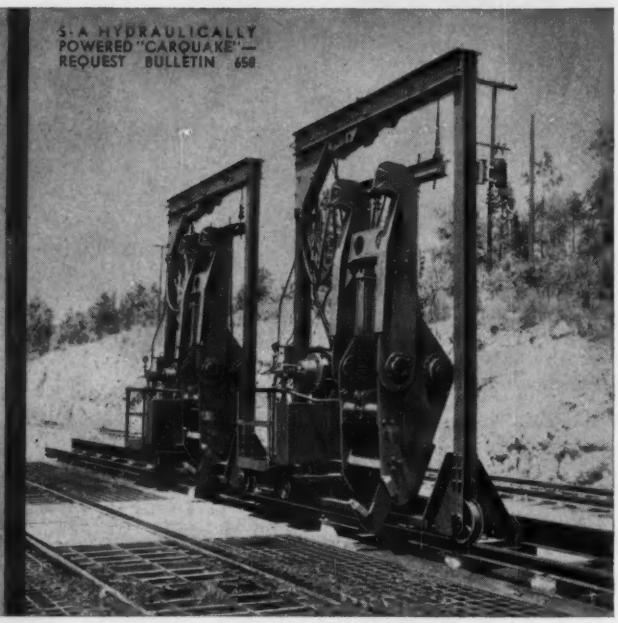
MOGUL

Products Company

Standard Building • Cleveland 13, Ohio

SPECIALISTS IN INDUSTRIAL WATER TREATMENT FOR OVER 40 YEARS

STEPHENS-ADAMSON



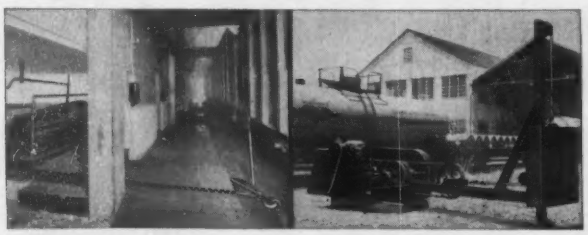
SPEEDS THE SPOTTING AND UNLOADING OF RAILROAD CARS

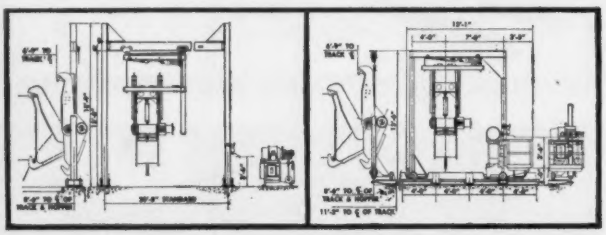
CONTINUOUS CAR PULLERS

S-A Continuous Type Wire Rope Car Pullers are cutting costs at many plants by speeding up loading and unloading of all types of railroad cars. Designed for installations requiring long hauls, cars can be moved in either direction on straight or curved tracks. Since each installation requires careful consideration, we suggest you let S-A Engineering Know-How help solve your specific problem.

HYDRAULICALLY POWERED "CARQUAKE"

One man easily unloads hopper-bottom railroad cars quickly, efficiently and with less noise than overhead car shakeouts. Hydraulically powered vibration utilizes controlled speed to match required capacity. The S-A "CARQUAKE" requires no expensive overhead structures . . . a completely self contained unit—unlimited movement parallel to track. The installation of an S-A "CARQUAKE" avoids demurrage charges —saves manpower—speeds unloading operations.





MODEL 963 DRUM TYPE WIRE ROPE CAR PULLER
Available in three sizes for heavy duty pulling and hoisting for rope pulls from 9,000 to 22,500 pounds. The pulling rope is deadended to drum, which holds enough rope to pull loads over distances of 250 to 500 feet. Where cars must be pulled and lowered on inclines, motor can be reversible.

MODEL 967 DRUM TYPE WIRE ROPE CAR PULLERS
Available in six sizes with rope pulling capacities up to 15,000 pounds. Pulling rope is deadended to drum, which holds enough rope to pull loads over distances of 390 to 727 feet. Where cars must be pulled and lowered on inclines, drive motor can be reversible.

TYPE "B" STATIONARY MOUNTED CARQUAKE
Designed for applications where only slight movement parallel to hopper cars and tracks is required. The unit is mounted to the customer's concrete hopper foundation or steel structure with anchor bolts.

TYPE "C" RAIL MOUNTED CARQUAKE
Mounted on rails permitting travel any desired distance and unloading into any hopper. Concrete piers or steel structure for anchoring rails are all customer need furnish.

WRITE FOR LITERATURE LISTED

S-A
ENGINEERED BULK HANDLING SYSTEMS
MATERIALS HANDLING PRODUCTS
SPEEDWALK® PASSENGER CONVEYORS
SEALMASTER® BALL BEARING UNITS
SPHERCO® BEARINGS & ROD ENDS

ENGINEERING DIVISION

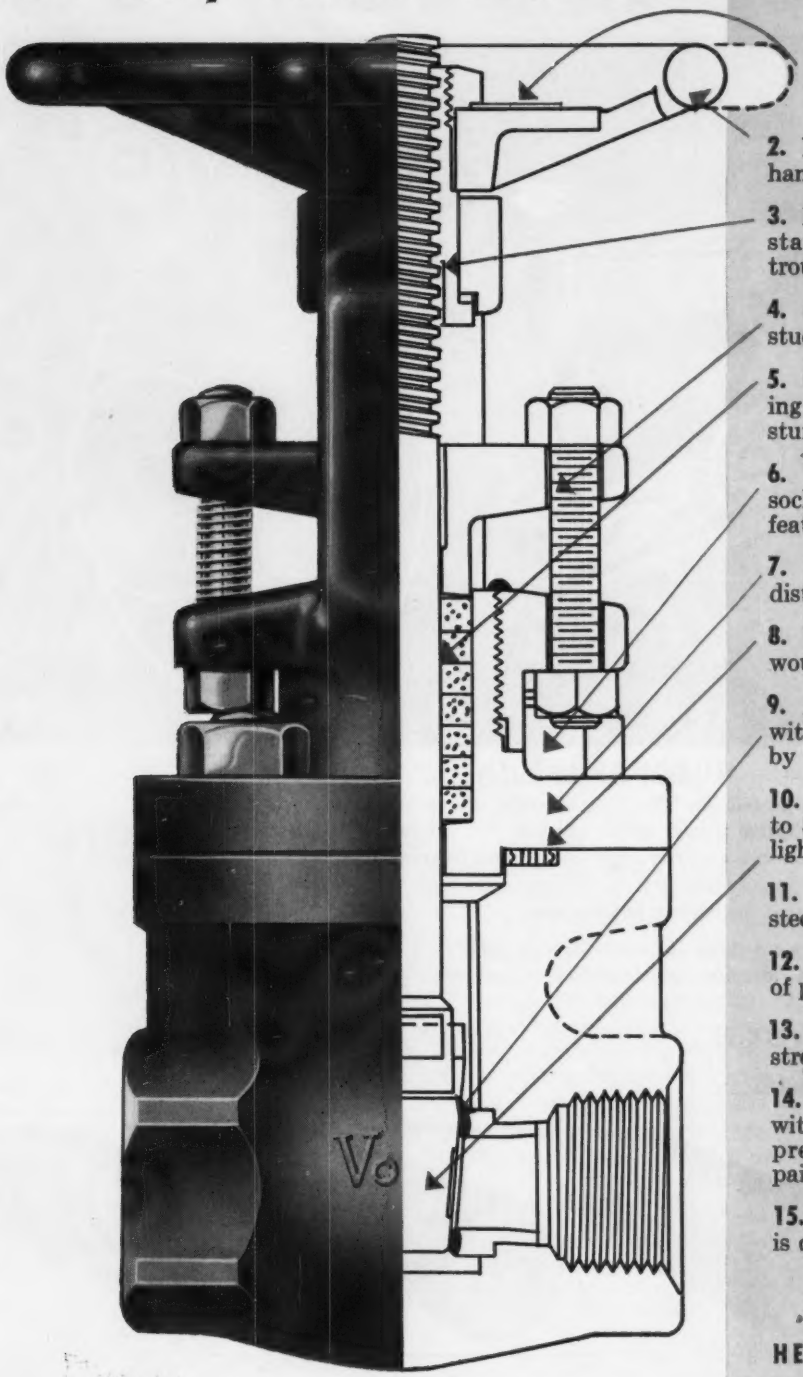
STEPHENS-ADAMSON MFG. CO.

GENERAL OFFICE & MAIN PLANT, 5 RIDGEWAY AVE., AURORA, ILL.

PLANTS LOCATED IN: LOS ANGELES, CALIF. • CLARKSDALE, MISS. BELLEVILLE, ONT. • MEXICO CITY, D. F.

For more facts circle 245 on Reader Service card, p 107

The only valves with ALL these features!



1. Complete identification on metal disc.
2. Depressed-center, knobbed handwheel avoids hand injury.
3. Hi-temperature, anti-galling stainless steel yoke nut insures trouble-free service.
4. Stainless steel packing gland studs and nuts won't corrode.
5. Quality general purpose packing in the only adequately sized stuffing box in the industry.
6. Bolting nuts have clearance for socket wrenches — a real safety feature!
7. Round bonnet flanges for even distribution of bolting stresses.
8. Widest, best designed, spiral wound gasket for leak proof service.
9. All gate valve seats hard faced with Stellite — standardized only by Vogt.
10. Stainless steel gates hardened to 500 Brinell with flatness of two light bands (.000022 inches).
11. All pressure parts are forged steel to insure safety.
12. Maximum interchangeability of parts.
13. Fillets on all corners increase strength.
14. All exterior surfaces are treated with a phosphate coating for rust prevention and as a base for painting.
15. A complete line of Vogt valves is carried in stock.

For literature write to Dept. 24A-FP.

HENRY VOGT MACHINE CO.

P. O. Box 1918, Louisville 1, Kentucky

Vogt

FORGED STEEL VALVES

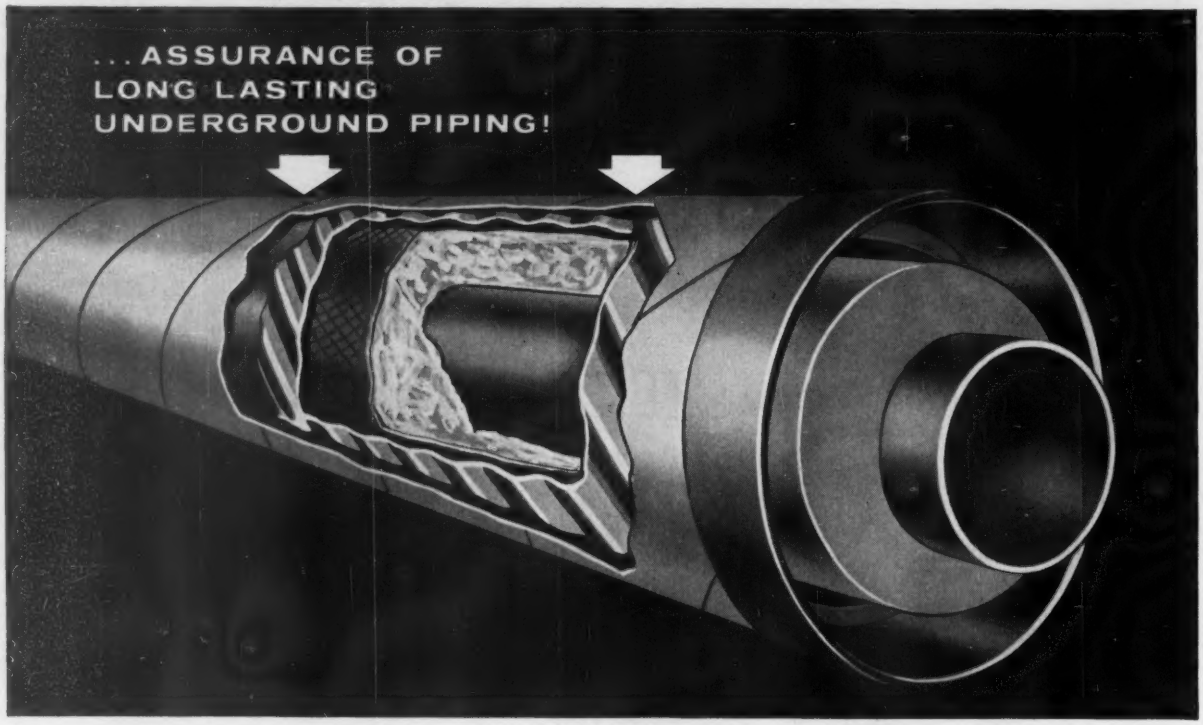
fittings, flanges & unions

SALES OFFICES: Camden, N. J., Charleston, W.Va., Chicago, Cleveland, Dallas, Los Angeles, New York, St. Louis

For Direct Long Distance to Louisville dial: 502 ME 4-9411

For more facts circle 246 on Reader Service card, p 107

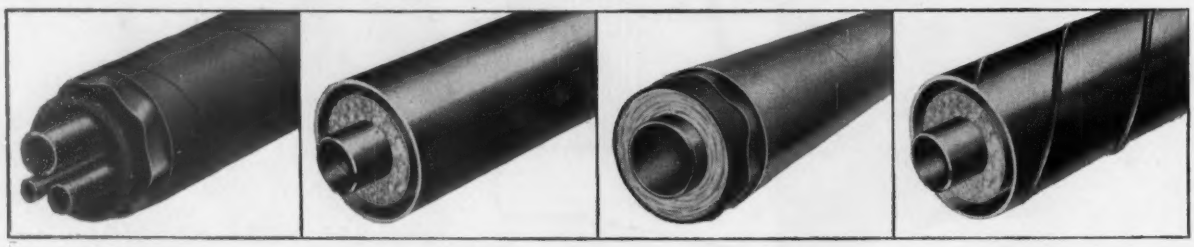
GALVANIZING



Hot-dip galvanizing of the Hel-cor Conduit in a Ric-wiL system offers the finest in corrosion protection. The Zinc actually alloys to the steel and becomes an integral part of the conduit . . . not just a surface coating. The Automobile Industry has announced through The American Zinc Institute that after testing 450 coatings, Zinc was best from the standpoint of resistance to corrosion.

The illustrated catalog offers a wealth of information on types' of systems, engineering, specifications, and installation methods . . . write today for your copy. . .

OTHER AVAILABLE
RIC-WIL SYSTEMS...



UNILINE | CAST IRON | LO-TEMP | IMPERIAL

Quality Piping Systems . . .
. . . of Exceptionally High Thermal Efficiency

RIC·WIL PREFABRICATED INSULATED PIPING SYSTEMS

CENTRAL OFFICE: RIC-WIL INCORPORATED, BARBERTON, OHIO
WESTERN STATES: RIC-WIL INCORPORATED, WESTERN DIVISION, NEWARK, CALIFORNIA
IN CANADA: THE RIC-WIL COMPANY OF CANADA LTD.

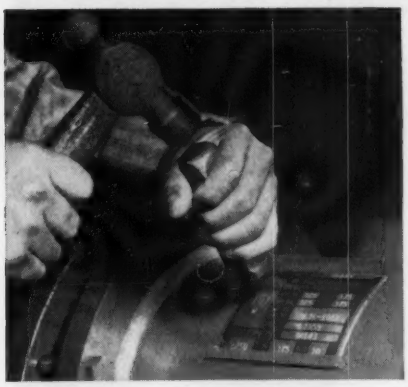
For more facts circle 247 on Reader Service card, p 107

FOR MORE DEPENDABLE HEATING AND COOLING OF LIQUIDS AND GASES

Cross section of Type "OC" Heat Exchanger showing floating head construction.

B&G TYPE "OC" HEAT EXCHANGERS

B&G Heat Exchangers are welded in specially designed fixtures by expert workmen.



All B&G Heat Exchangers are built to A.S.M.E. Code requirements and are so stamped.

For heating or cooling a wide variety of liquids and gases, "OC" Heat Exchangers offer numerous design and construction features which are a warranty of long life and efficient performance.

These units have removable tube bundles with an internally packed floating head. Sizes range from 6″ through 30″ diameters, lengths from 2′ through 20′. Standard material includes steel shells and tube sheets, cast iron heads and copper tubes. Stainless steel tubes, tube sheets and heads are also available. The design of "OC" exchangers may be varied for channel or bonnet heads in both single and two-pass construction.

B&G "OC" Heat Exchangers are not only engineered to top efficiency but are constructed to the uncompromising standards of quality and safety demanded by the A.S.M.E. Code.

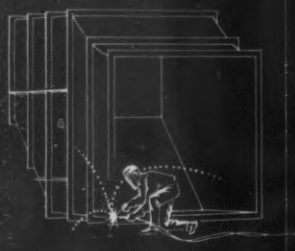
With each B&G "OC" Exchanger, a Manufacturer's Data Report for Unfired Pressure Vessels, Form No. U-1, as required by the A.S.M.E. Code rules, is furnished. This form is signed by a qualified inspector, holding a National Board Commission, certifying that the construction conforms to the latest A.S.M.E. Code for unfired pressure vessels. The A.S.M.E. "U" symbol is stamped on each exchanger.

These exchangers are custom-designed units, built to your specifications. Inquiries are invited.

BELL & GOSSETT
COMPANY
Dept. GT-36, Morton Grove, Illinois

Canadian Licensee: S. A. Armstrong, Ltd., 1400 O'Connor Drive, Toronto 16, Ontario

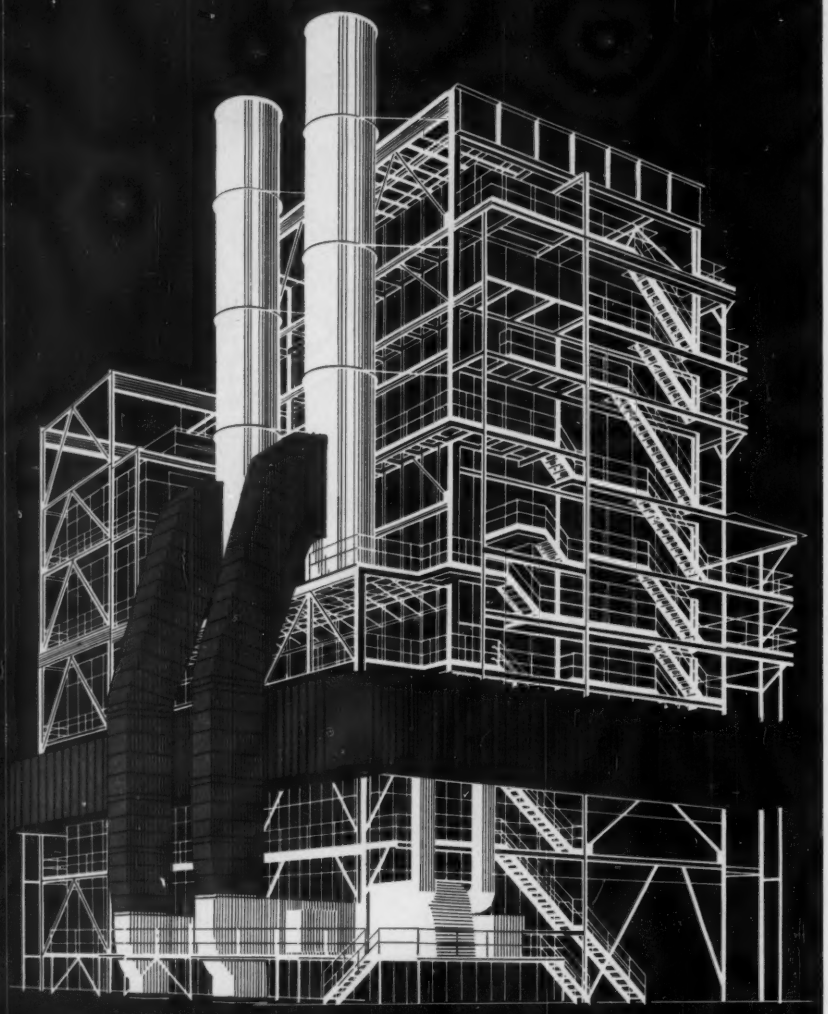
For more facts circle 248 on Reader Service card, p 107



Breeching panels are factory prefabricated and/or pre-insulated; match-marked for shipment.

DeVilbiss combines insulation and lagging into a prefabricated panel, reducing insulation costs.

Experienced DeVilbiss crews are available to handle complete job-site assembly and erection.



pre-insulated breeching is a new concept pioneered by DeVilbiss' Metal Fabricators Division. It means prefabricating lagging and insulation in a single operation at the factory. Benefits to you: substantial reduction of field-insulation costs, reduced corrosion, increased thermal efficiency. Specialists work with you, from blueprint detailing to erection in your plant.

Talk to DeVilbiss about all your power-plant breeching requirements

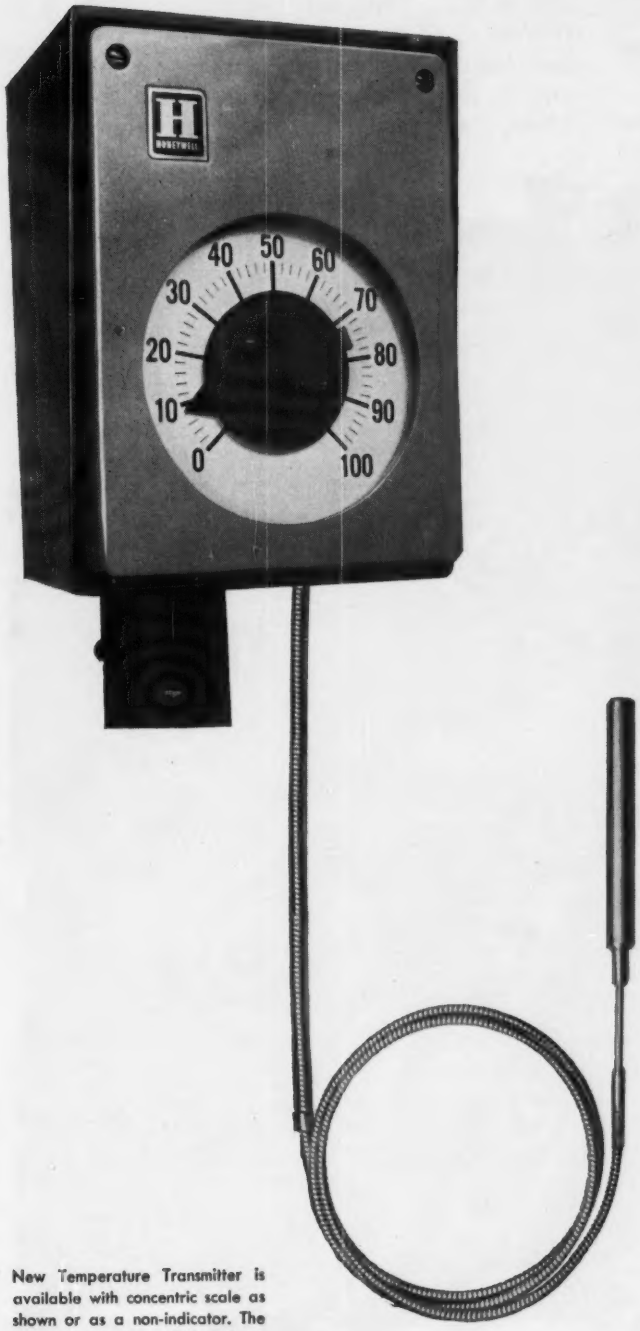
FOR TOTAL SERVICE, CALL
DE VILBISS

THE DeVILBISS COMPANY, Toledo 1, Ohio. Also Barrie, Ontario; London, England; São Paulo, Brazil. Branch offices in principal cities.

For more facts circle 249 on Reader Service card, p 107

NEW TEMPERATURE TRANSMITTER

offers thermal system options with ranges from −125° to 1000°F



New Temperature Transmitter is available with concentric scale as shown or as a non-indicator. The unit transmits with calibrated accuracy of ±0.5% of full scale, and indicates within ±1.0% of full scale.

Completely new, completely flexible, the new Honeywell Temperature Transmitter gives you a choice of either gas or mercury thermal system plus a wide selection of measuring bulb styles. Die-cast aluminum case is 4″ by 7″ by 9″. Concentric scale is 8½″ long.

New built-in rebalancing capsule automatically compensates for changes in ambient temperature. Two-way overload protection covers 100% of span. Maintenance is greatly simplified by modular construction which lets you remove any major component by loosening two screws. All field adjustments are easily accessible, and a self-locking feature prevents upset after calibration adjustments are made.

Transmitter Features: Gas (—125° to 800°F) and mercury (—40° to 1000°F) actuated thermal systems with bulbs for any application. Mount on pipe welded to flow line, or on bracket that clamps on the hex head of the socket. Vibration resistant thermal system means accurate measurement on vibrating flow lines.

For more complete details on the new Temperature Transmitter, call your nearby Honeywell field engineer. Or write for *S630-1*. MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa. In Canada, write Honeywell Controls, Ltd., Toronto 17, Ontario.

Honeywell

First in Control

SINCE 1885

HONEYWELL INTERNATIONAL Sales and Service offices in all principal cities of the world. Manufacturing in United States, United Kingdom, Canada, Netherlands, Germany, France, Japan.

POWELL PERFORMANCE PAYS OFF

Any way you look at it, Powell Valve performance really pays off—performance that's conclusively proven in power plants everywhere.

You can find at Powell any type of valve you may need to handle water, oil, gas, air, steam, corrosive fluids, even molten metals and other radioactive materials used in atomic power plants.

Consequently, Powell can help simplify flow control projects and contribute real savings in time and money. For example, in describing a modern 125,000-KW steam-electric generating plant, a leading authority recently listed some 80 areas requiring a total of over 1300 valves . . . Powell could have supplied almost every one.

Learn how this Powell performance can mean a real payoff for you. Contact your nearby Powell Valve distributor, or write direct.

300-pound Steel Globe Valve with welding ends. Outside screw rising stem and yoke. Bolted flanged bonnet. Screwed-in seat ring. Sizes, 1" through 12". Screwed or flanged end valves are available.

600-pound Steel Swing Check Valve with welding ends. Bolted flanged cap. Disc hung on a 5° angle allows full flow through when wide open. Screwed-in seat ring. Sizes, ½" through 8". Can be furnished with flanged or screwed ends.

150-pound Steel Gate Valve with welding ends. Outside screw rising stem and yoke. Bolted flanged bonnet. Solid wedge disc, screwed-in seat rings. Sizes, ¾" through 30". Can be supplied with screwed or flanged ends.

115th year of manufacturing industrial valves for the free world

POWELL STEEL VALVES

THE WM. POWELL COMPANY CINCINNATI 22, OHIO

For more facts circle 251 on Reader Service card, p 107

LOUIS N ROWLEY, EDITOR • AUGUST 1961 • ESTABLISHED 1882 **Power**

Who cares about industrial relaying?

In some plants, nobody. At least that was the case in some of the industrial and institutional establishments surveyed in a recent study of protective-relaying practice. A problem now, this indifference promises to become more critical as electrical systems grow in size and complexity.

The study revealing these conditions was presented at the AIEE Summer General Meeting in a technical paper by POWER's Managing Editor Jim O'Connor and Associate Editor Norm Peach. Their 27-plant survey found exceptionally well-engineered relay systems in a few plants (usually newer ones), crude and ineffective schemes in others. And they found that degree of relaying adequacy varied widely between these extremes, depending on the influence of the local utility, the electrical manufacturer supplying the gear, the consultant, and, of course, the plant electrical staff.

Unfortunately, a true knowledge of protective relaying and the important role it plays in industrial production was often lacking. In some plants visited, even the electrical engineer in charge of distribution failed to have a sound grasp of his relay system. In small plants without the professional services of an engineer, the electrician was all too often totally unaware of the philosophy of modern electrical protection and devoid of the skill needed for relay maintenance.

To many of these latter plants, the supplying utility has made available the services of its relay engineers and testers, either as a customer service without charge, or for a fee. The service varies widely from utility to utility. Some go all-out: supply relay engineering service to the industrial customer when his plant is being built, offer assistance of trained technicians when the system starts operation, follow up periodically by sending in relay testers.

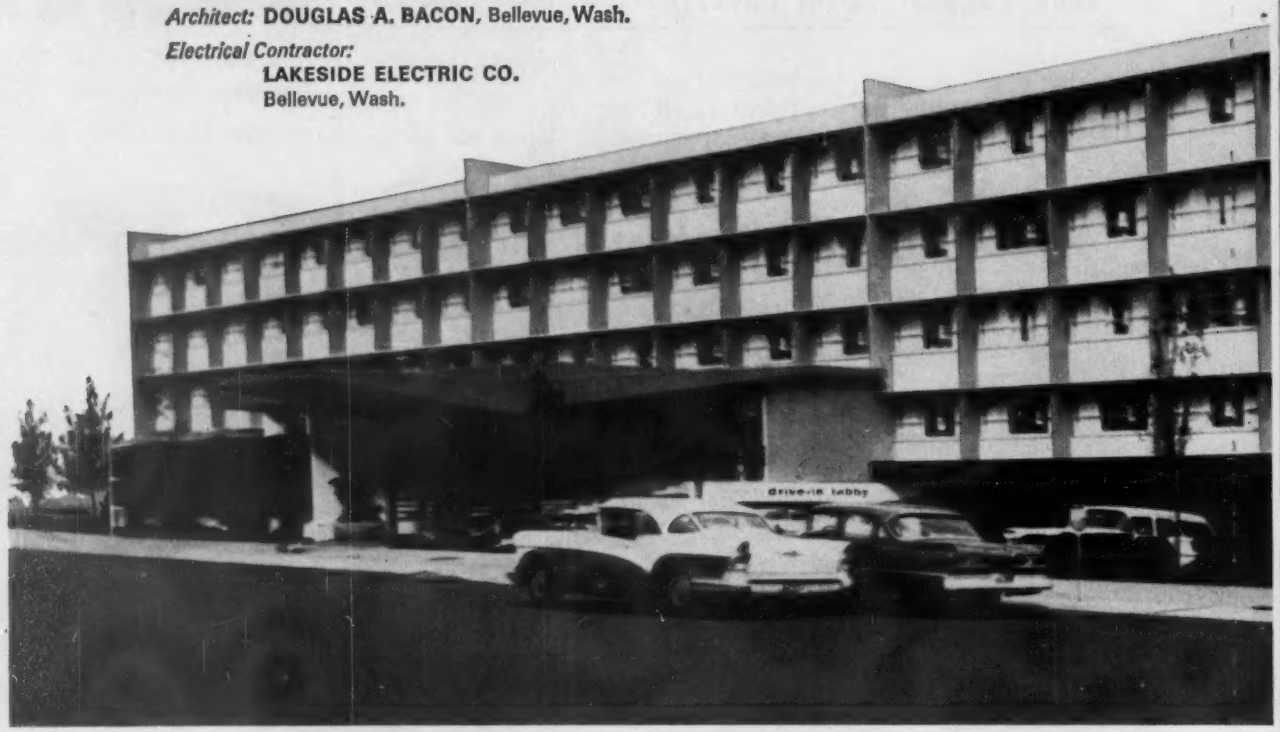
The survey also showed that some utilities hesitate to cross the line separating their systems from those of their customers, while many who now do customer relay work would like to discontinue. This may reflect concern about the question of legal responsibility should an electrical accident on a customer's system be traced to faulty operation of a utility-tested relay, or to the feeling that the utility's prime obligation is to provide low-cost electrical power and not to serve as a consultant or maintenance man. Whatever the reason, utilities are generally discouraging further commitments in the customer-relay area.

Seeing that utilities wish to divorce themselves from customer-relay problems, and industrials are too often unaware of the important role their relays play in system protection, a serious problem is being compounded—growing in magnitude while the demands placed on relaying keep increasing.

One obvious solution is for industrial management to build effective maintenance programs and train men to carry them out. Consulting engineers might well extend their practice to include preparation of specific relay-maintenance procedures for client plants. And they might further assume responsibility for supervising the program once it is initiated.

In any case, the protection of industrial electrical systems needs to be more widely understood and appreciated. This month's special report, beginning on p 67, is a step in this direction. And if you want a copy of the AIEE paper referred to in this editorial, write us—we'll supply single copies without charge while the supply lasts.

Owner: **DORIC CO., Seattle, Wash.**
Architect: **DOUGLAS A. BACON, Bellevue, Wash.**
Electrical Contractor:
LAKESIDE ELECTRIC CO.
Bellevue, Wash.



Electrical Protection goes MODERN *with* BUSS Fuses...

at the Doric 6th. Avenue Motor Hotel, Seattle, Wash.

Travelers staying at this new, luxurious 175 unit motor hotel enjoy the latest conveniences of electrical living. Even the rooms are heated electrically so each person may select the room temperature he prefers.

These modern services require large electrical capacity. As a result, the available fault current is approximately 70,000 amperes.

Safe protection against faults of this magnitude is assured by the BUSS Hi-Cap fuses installed in the main entrance service. These fuses have an interrupting rating of 200,000 amperes rms. symmetrical.

To maintain safe, modern protection throughout the electrical system,—and to safeguard against unnecessary interruptions in electrical service, FUSETRON dual-element fuses are installed in the branch circuit switches.

ANOTHER BUSS HI-CAP AND FUSETRON FUSE INSTALLATION

Mr. S. Andrew Sharpe, Manager of Lakeside Electric Co., at main switchboard of Doric Motor Hotel.

Mains and feeders protected with BUSS Hi-Cap fuses. Branch circuits protected by FUSETRON dual-element fuses.

There is a safe, modern BUSS or FUSETRON fuse with specific characteristics to match your requirements.

Available from BUSS: High interrupting capacity fuses to protect against fault currents up to 200,000 amperes; current-limiting fuses to restrict let-thru fault currents to safe values; long time-lag (dual-element) fuses to prevent needless outages on harmless overloads.

And with Fuses safe protection remains safe. BUSS and FUSETRON fuses are just as safe and accurate 20 years or longer after installation as on the day installed. Dust, fumes, corrosion or age cannot prevent them from opening when they should.

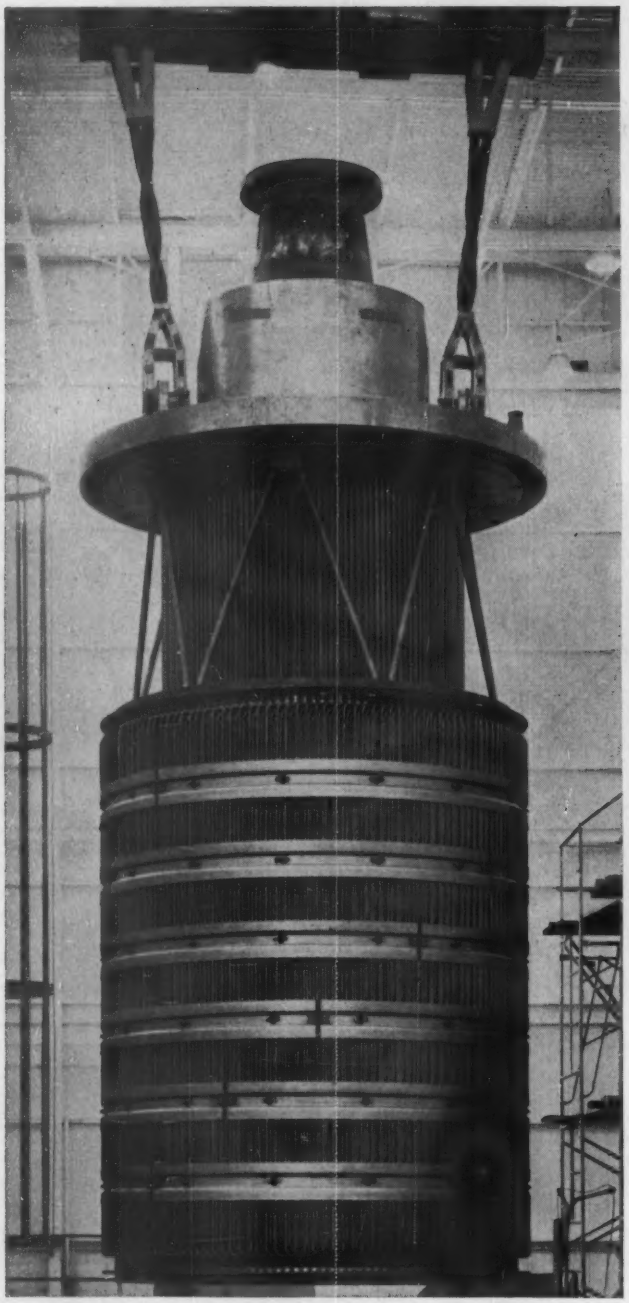
For more information on

FUSETRON dual-element fuses
(loads of 0 to 600 amps.) ..... **write for bulletin FIS**

BUSS Hi-Cap fuses
(loads above 600 amps.) ..... **write for bulletin HCS**

BUSSMANN MFG. DIVISION, *McGraw-Edison Co.,* **ST. LOUIS 7, MO.**

TOMORROW'S POWER



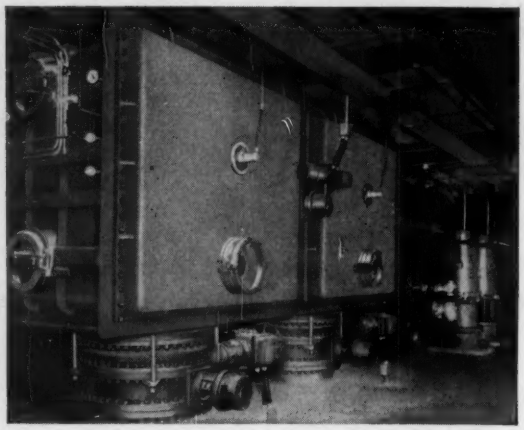
and

C. H. WHEELER / GRISCOM-RUSSELL

COMBINED INGENUITY

AND SKILL BUILT IT.

Three identical Griscom-Russell Vertical Once-Through Involute Tube, Liquid Sodium Heated Steam Generators (one of which is shown here)—have been installed and are being tested at the Enrico Fermi Power Plant built by the Power Reactor Development Corporation. These generators—first of their kind ever built—are an important break-through in the continuing efforts to produce steam from nuclear power more economically.



This 50,000 sq. ft. C. H. Wheeler Condenser at the new Indian River Plant of the Orlando (Florida) Utilities Commission, serves the 78,500 (rated capacity) turbine-generator. Its special deaerating features saved money in installation costs. C. H. Wheeler Ejectors, Circulators and the Condensate Pumps shown at the right also serve this new plant.

GRISCOM-RUSSELL / **C. H. WHEELER**

Massillon, Ohio — Philadelphia 32, Pa.

From this combined source you may now select condensers, circulating, condensate and general service pumps, steam jet ejectors, feedwater heaters, evaporators, generator gas coolers, tank heaters, heat exchangers, or special steam generators . . . all engineered and coordinated to meet the performance and space requirements of your power station.

472

For more facts circle 253 on Reader Service card, p 107

Protective Relaying

For industrial electric-distribution systems

By NORMAN PEACH, *Associate Editor*

We look upon fuses and circuit breakers as our protectors against electrical-distribution faults. While a fault-sensing ability is inherent in the fuse, the breaker requires a current-measuring device to trigger its main contacts. Fault sensing and breaker-contact triggering are, in essence, a relay's sole job.

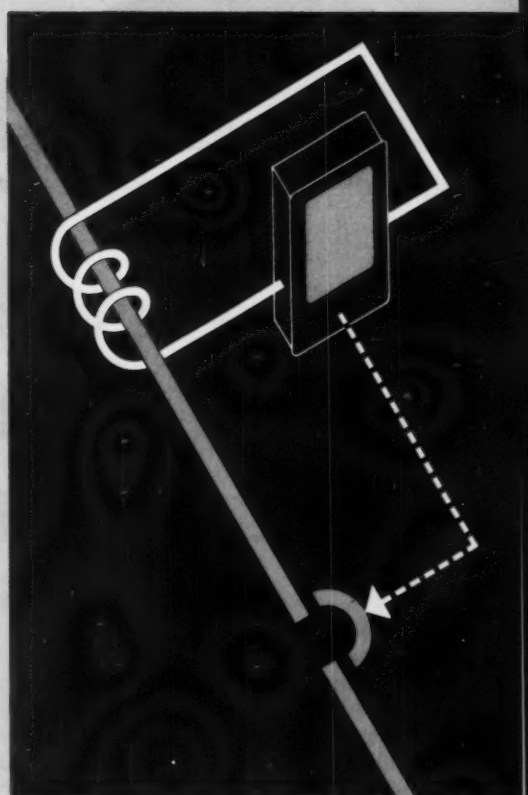
This report tells you what relays are, how they operate, how to coordinate them with other relays, fuses and direct tripping devices—and, of growing importance, how to maintain them.

Many of today's industrial plants lean heavily on utility relay-test people to assist in coordination, setting and maintenance of their protective-relaying equipment. For many reasons, including that of possible legal responsibility should an electrical accident be traced to faulty relay operation, the power companies are bowing out of the customer-relay business.

So more energy-systems engineers in industrial plants and in consulting capacities will have to assume greater relaying responsibilities, and rightly so, in light of the utilities' position. With industrials reaching out and encompassing the main primary substations, need for relay know-how is even greater.

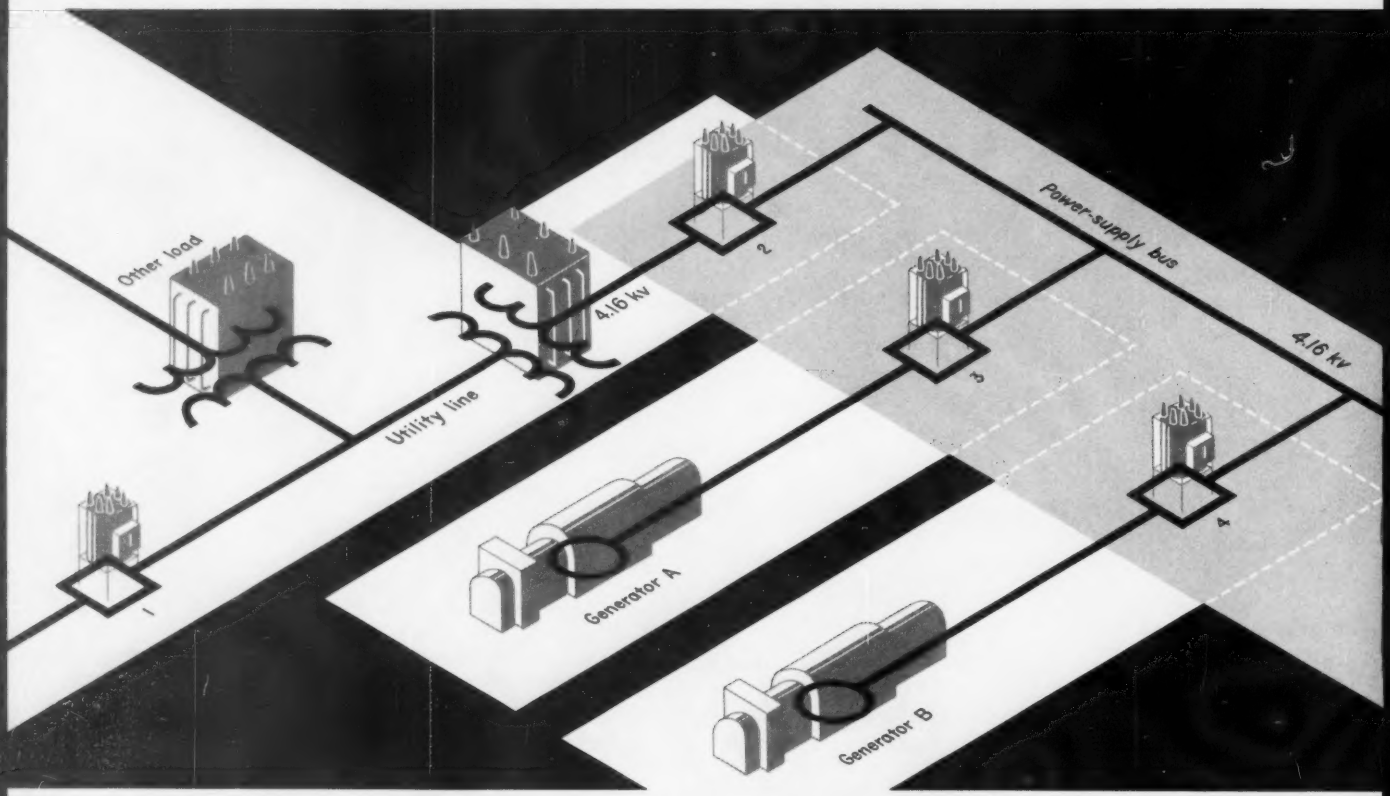
As pointed out by POWER editors in a recent AIEE technical paper, electrical systems in industrial plants are growing in size and complexity. This growth has been occurring over the years and will continue. It will continue as long as industry demands higher, continuous and automated production.

Coupling growth to ever-widening areas of electrical responsibility brings the need for highly reliable coordinated protection to the forefront. With available short-circuit currents still climbing, relays, the heart of most protective systems, are assuming even greater importance throughout the industrial scene.



a **Power** special report August 1961

Although protective relaying is planned on a system basis . . .



ZONES OF PROTECTION surround major circuit elements and overlap around key circuit breakers. Thus faults in any

Relays interpret trouble signals to trigger breakers

System or circuit faults are cleared by fuses or circuit breakers: This is basic and is covered in POWER's June 1958 special report, *Electrical Distribution Protection.* The fuse serves as both fault sensor and circuit interrupter. In circuit breakers designed to operate below 600 volts, fault sensing is often accomplished by direct-acting series trip coils which are built right into the breaker. But in breakers above 600 volts, fault sensing is generally done by relays which in turn trip breakers.

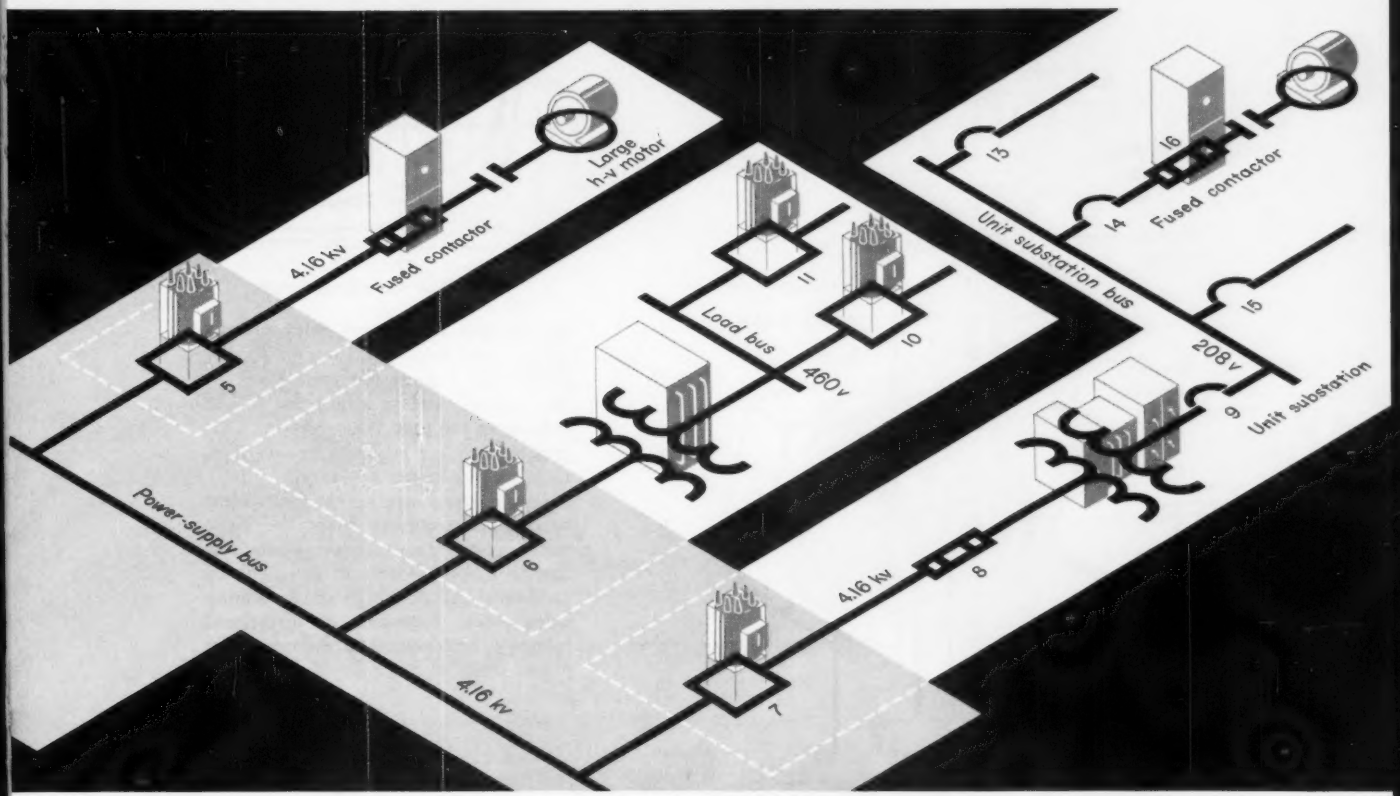
What is a relay? In rather formal terms, the proposed standard for *Relays and relay systems associated with electric power apparatus* (revision of ASA C37.1) defines a relay as "an electrical device which is designed to respond to input conditions in a prescribed manner and after specified conditions are met to cause contact operation or similar abrupt change in associated control circuits." In more practical terms, a relay's job is to monitor a host of complex circuit conditions: current and voltage magnitudes, phase relations, direction of power flow and frequency. When an intolerable condition is detected, the relay operates, completing the trip-coil circuit of a breaker. The trip circuit is usually dc.

Speed and selectivity are two demands generally placed on protective relaying: speed in disconnecting the faulty portion from the overall system and selectivity in that disturbance to remainder of system is held to a minimum. Attaining these demands calls for comprehensive planning of the complete relay scheme as a unit. Look upon protective relaying as a form of insurance—and low-cost insurance at that, when you consider the cost of possible outages, personnel injury, property damage.

System shown above is not ideal, nor should it be considered typical of industrial plants. What our drawing does show is a variety of conditions which require consideration when planning relay protection. Your plant may be simpler in that the utility service more nearly matches utilization-voltage demands. Or it may be more complicated, requiring ties between different parts.

At left of drawing we see a utility line feeding a step-down transformer, then tying to the main in-plant bus. The bus is also fed by plant-owned generators *A* and *B*. Note that the utility supply also serves another customer

. . . individual relays guard specific areas against faults



part of the system are isolated by breakers or fuses. A well-designed relay scheme minimizes general disturbance

—if a fault in the plant shown trips utility breaker *1*, the neighboring plant as well as your own will be down. And naturally the converse is true. This is one reason for working closely with the utility in designing protection.

In a system properly designed and coordinated, circuit breaker *2* should be able to clear any fault current the utility system can supply (to faults originating on load side of breaker *2*) without tripping breaker *1*. However, if *2* fails to clear, *1* serves as *backup* protection.

Now suppose breaker *1* opens for some unknown reason; plant generators *A* and *B* would tend to feed *out* through breaker *2* to handle load in the neighboring plant. In attempting to handle load in both your plant and the neighbor's, generators *A* and *B* would probably be overloaded. Let us further suppose breaker *1* tripped because of a fault somewhere in the line between *1* and *2*; then reverse current through *2 might* run high enough to trip itself.

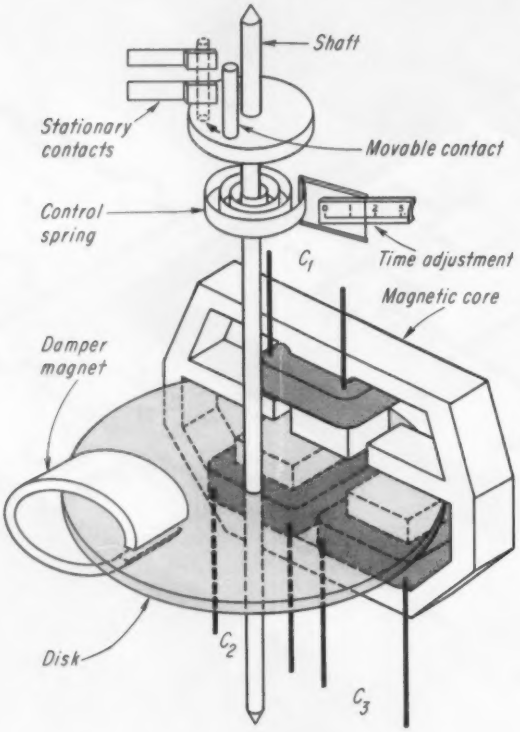
But if breaker *1* trips through improper operation or because of a general utility-system failure, plant generators will feed your neighbor's plant unless he drops load. All this points up the need for protective relaying on breaker *2*, which not only operates on excessive current in the normal direction but on moderate currents when power flow is reversed. This is accomplished with *directional relays* as discussed later in the report.

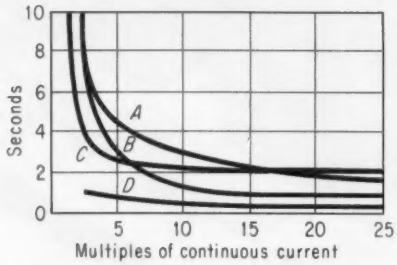
Zone of protection surrounds each major element in the system shown: the utility supply, the in-plant bus, each generator and feeds off the main bus. Note that these zones or areas overlap around a circuit breaker. Thus breaker *3* protects generator *A* from faults on the bus while keeping the bus from feeding into a fault on generator side of breaker *3*. Breakers *5*, *6* and *7* form a zone which overlaps onto the load side of the bus.

To keep things simple, all current and voltage (potential) transformers were omitted from our drawing. In real life the ct's and pt's are nearly always used with protective relays since the magnitudes of current and voltage are too large for relays to handle directly. Key to defining the zone of protection is in the location of the ct's and pt's. Their placement in the electrical system pins down the geographical area associated breakers will respond to through their protective relays.

Far right of drawing shows fuse *16* protecting the system from short circuits or grounds in motor, controller or leads. (There would be separate protection against motor overloading, which is beyond the scope of this report.) Breaker *14*, located in a secondary unit sub, has as its main job the protection of the feeder running out to the motor fuse. But this same breaker serves as backup should the fuse fail to clear a fault. Breaker *9*, while intended primarily for protection of the unit-sub bus, also serves as backup for breaker *13*. Unit-sub transformer is protected by fuse *8*, with breaker *7* guarding the feeder.

Typical time-delay relay has induction-disk construction





Inverse-time overcurrent relay characteristics are shown: *A*, inverse; *B*, very inverse; *C*, definite minimum time; *D*, high speed. Relays adjust for 0.1 or 0.05 times the time values shown. Current settings are adjusted by coil taps, time settings by contact travel.

Besides basic inverse-time overcurrent relay, manufacturers adapt the basic watt-hour-meter induction-disk construction to a wide variety of functions by combining inputs to coils and by adding extra poles. Example: ac directional relays, p 76, respond to differences in phase angle of their input quantities.

Induction, electromagnetic or solid-state principles underlie relay action

Before considering the particular ways in which relays can protect a system, let's look at their basic types of construction. A speaking acquaintance with the relay's design will help us understand how the unit goes about its protective task.

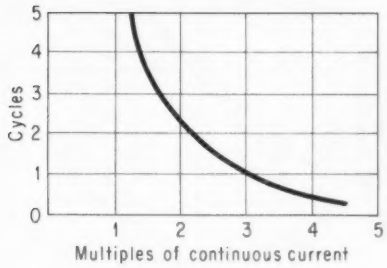
Basic relay constructions shown on this and the next three pages are modified to a greater or lesser degree to cope with their myriad functions. But in spite of the great variation in types and appearance of relays, fundamental differences actually are few. Relays that we shall consider operate in response to one or more electrical (in one case nonelectrical) quantities either to close or to open contacts. There are really only three different operating principles involved: (1) electromagnetic attraction (2) electromagnetic induction (3) solid-state physics as used in the static or semiconductor type of relay, a recent introduction to the field.

Plunger type relay, top right, is a simple example of electromagnetic attraction. When there is less than a preset value of current in the coil, the magnetic flux produced is not strong enough to draw the plunger upward into a position where the movable contact bridges the stationary contacts. When current reaches the preset value, it produces enough flux to raise plunger and close the contacts. You can adjust the magnitude of coil current or voltage which will cause contacts to close, either by taps on the coil or by changing plunger position at rest.

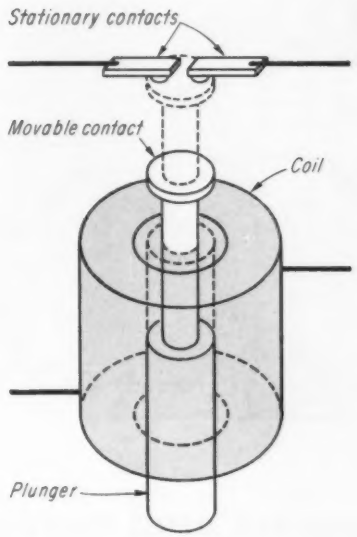
Adding some retarding device such as an air dashpot produces a time delay. The dashpot attaches to the relay plunger so that upward (contact-closing) motion of the plunger moves a piston in a small stationary cylinder. The magnetic force attracting the plunger pulls the piston upward along with it. As it rises, piston compresses the air in cylinder, which resists and slows the upward motion. But cylinder vents let the air escape slowly, so eventually the plunger rises into the contact-closing position. Vent size is adjustable; therefore the rate at which air escapes determines how fast the relay responds to the electrical quantity.

Induction type relay is essentially a split-phase induction motor with a shaft designed to close contacts. A movable element or rotor (a disk or cup of nonmagnetic conducting material, usually aluminum) develops actuating torque. Basic induction-disk design is shown above, left. Out-of-phase ac quantities derived from one or more sources feed to the coils. The coils' flux induces eddy

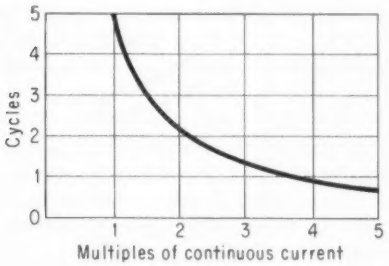
Plunger type relays are common instantaneous units



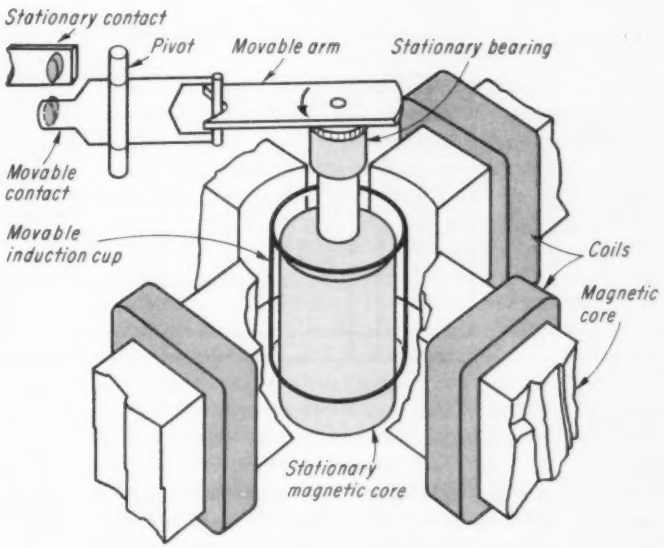
Instantaneous element is usually associated with a time-delay unit in the complete overcurrent relay, and here the plunger type often fits in. Note that the "instantaneous" relay actually does have an inverse-time curve, though it's a fast one. These units may also serve as undervoltage and auxiliary relays. Direct-acting series trip of l-v breaker is a modified plunger with time delay.



Induction-cup principle meets need for high speed



High-speed applications are its chief job, but this form of induction relay can adapt to a variety of functions. It is a more efficient torque producer than induction-disk types of either watt-hour-meter or shaded-pole design. Induction-cup or cylinder structures may have extra poles, added between those shown. Each pole produces main torque in conjunction with its adjacent poles.

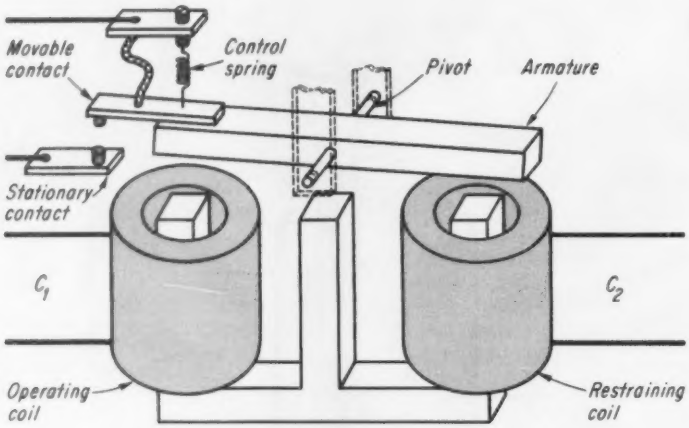


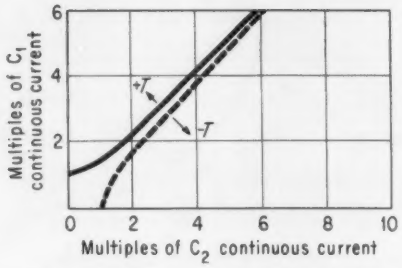
currents in the disk. Then, reaction between flux of the stationary coils and flux produced by eddy currents in the disk produces torque. (This magnetic-core arrangement is akin to a watt-hour meter.) The damping magnet controls oscillations of the disk. When the disk has produced enough torque to overcome control-spring torque, it turns, and the contacts close.

A similar design uses a single coil supplied from one source. This design, with shaded-pole construction, produces disk torque by a copper shading ring encircling part of each pole face at the air gap. Air-gap flux is thus split into two out-of-phase components, as in the shaded-pole design of small single-phase motors.

Rings may be replaced by coils to further control working torque of the shaded-pole relay. When shading coils are short-circuited by a contact of another relay, torque will be produced; when open-circuited there will be no phase-splitting of the flux and consequently no torque. This sort of torque control may fit a directional function. (Directional relays are described on p 77.)

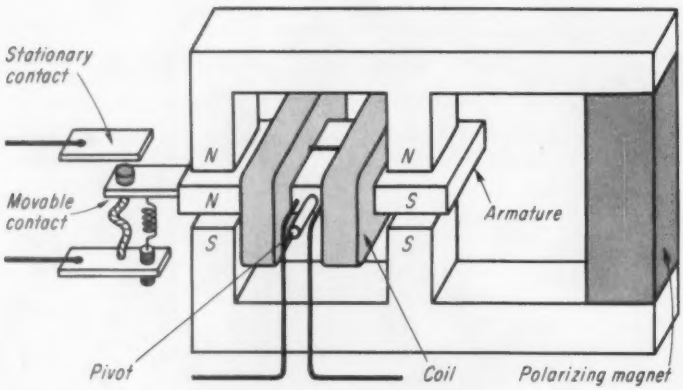
Balanced-beam relays compare values of current or voltage

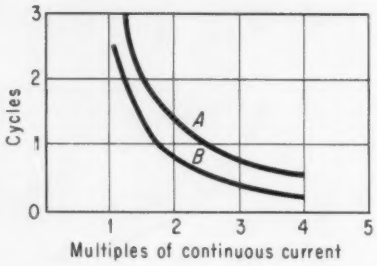




Unbalanced current or voltage causes one coil's torque to overcome that of the other. Positive torque produced by C_1 is represented by $+T$, negative torque produced by C_2 by $-T$. Relay doesn't work in intermediate band.

Polar designs are used mainly for directional relays





Dc directional relay shown may be actuated by rectified ac quantities such as the signals from electronic devices. Polar relays are essentially instantaneous, but variations include a magnetic damper, curve *A*. Curve *B* is undamped.

Induction-cup relays, p 71, most closely resemble the construction of an induction motor. However, the rotor iron is stationary, and only the conductor portion or *cup* of the rotor is free to turn. The cup and movable arm in sketch are supported by a stationary bearing fitting in a bracket (not shown). Torque produced in cup causes the arm to move; this motion in turn closes the contacts. You can get almost identical performance using an induction loop (two coils at right angles to each other) but the induction cup has largely replaced this method.

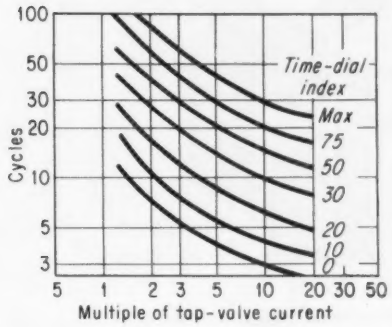
Balanced-beam relay construction, shown top, above, has been superseded in modern relays. But its operating principle is important. An armature is balanced on a pivot and held open by a control spring. Operation depends upon current ratio in coils C_1 and C_2. As long as currents in the two coils stay in proper ratio the relay remains open, though magnitude of these currents may change. When current in C_1 gets far enough above the proper ratio, the relay closes its contacts.

Balanced-beam relays may also be designed to work as single-coil overcurrent relays. These are desirable where low burden is important; for example, when you're setting for low ground currents or low-ratio bushing ct's. To adjust, change coil taps or core screws—latter changes the total air gap in magnetic circuit.

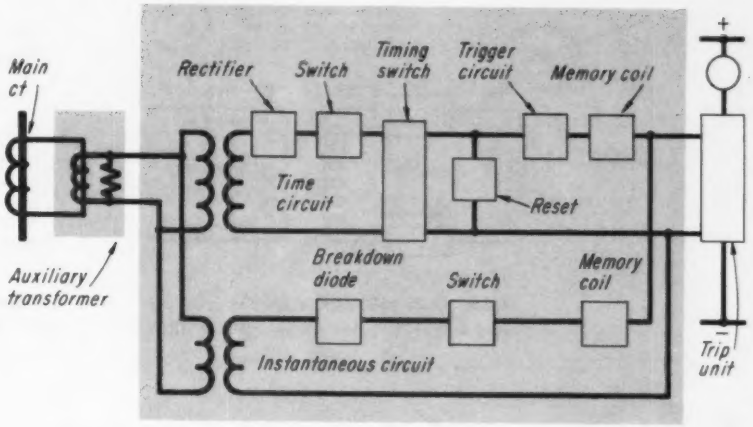
Polar relays, above, have a movable armature magnetized by the dc flowing in encircling coils. Proper polarity holds the armature in a position with contacts open. Reversing dc polarity reverses magnetic polarity at armature ends; then contacts close. Sketch shows a permanent magnet as the polarizing force, but a polarizing or field coil energized with dc could also be used.

Polar relays are more efficient than plunger or clapper types from the standpoint of actuating-coil energy. They

New static relays, although yet unproved, hold much promise



Overcurrent relay's time dial gives continuous selection between extremes of the time-current characteristic curves.



have a far lower burden (power requirement) than nonpolar types. For this reason they're a good choice when a dc shunt is the actuating source, whether you're aiming for directional action or not.

Static relays are new, block diagram and curves above. In some forms, they are now being tested in the field. The most interesting, perhaps, are static overcurrent relays, designed for all power-system applications which presently use induction-disk and plunger type relays. They coordinate with electromechanical and other static relays. Their design lets them work from standard 5-amp current transformers with low burden (drawing little power), and operate standard circuit-breaker trip coils from 125-v-dc control-power sources.

Static-relay proponents suggest a number of reasons for adoption of the solid-state devices. Not only do they have no moving parts, but they won't transfer material, as vacuum tubes do, so there's no chance of wear and (relatively) no aging. Adjustment promises to be simpler. Less panel space is needed. High speed is inherent. Relay resets almost instantaneously, since it lacks mechanical inertia. Thus closer coordination (p 80) is possible between static than between electromechanical relays. Relay curves may improve with respect to coordination with fuses, but for the present it's more important that curves coordinate with existing nonstatic relays.

What are components of static overcurrent relays? Conventional resistors, capacitors, transformers, along with more recently developed semiconductor devices such as diodes, transistors, thermistors and varistors make up the list. Besides the relay itself, an auxiliary transformer with a resistor across its secondary, plus a trip unit and pushbuttons with target-light indicator and reset, are used in the static-relaying scheme. First a standard current transformer senses in the usual manner, and the ct's 5-amp output can go to conventional ammeters or other instruments.

Because static relays have a high input impedance, their power requirements are small. Therefore, an auxiliary transformer is used, its primary connected to ct secondary. Since the relay itself is voltage-sensitive, a fixed resistor, placed across the auxiliary transformer's secondary, converts the current signal to a voltage signal.

Here's how the static relay of one manufacturer operates: line overcurrent causes auxiliary transformer's secondary-resistor voltage to increase proportionally; voltage feeds into the relay's inverse-time circuit. This circuit won't go into operation until the signal exceeds a definite voltage value at which a diode conducts and a capacitor begins to charge; that is, the relay picks up. Further increase in voltage increases capacitor charging rate. When a predetermined charge is reached, transistors begin to conduct, emitting a pulse signal which goes to trip unit. On a high-current fault, the instantaneous element senses the fault and signals the trip unit immediately.

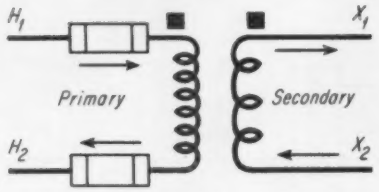
The trip unit is nothing more than an off-on electronic switch capable of handling current of circuit-breaker trip coil. Trip unit is in series with trip coil across a 125-v dc tripping battery, and breaker has an auxiliary switch which opens the trip circuit when breaker opens.

Neon lights, working in conjunction with two digital-computer-style memory cores, indicate operation. When the relay goes to work it energizes a core. Then you push a panel button marked "read" which lights a lamp, and this shows whether trip was initiated in time-delay or instantaneous sections. Light stays on till you reset.

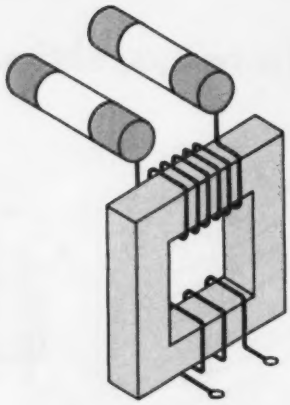
Pickup voltage is adjusted by means of the *tap dial* in conjunction with a tap from the auxiliary transformer. The *time dial* provides continuous time selection between the two extremes of the time-current characteristic envelope. The *instantaneous dial* continuously selects instantaneous pickup within any instantaneous trip range. The *time-current-band* adjustment gives you a choice of four different time-current bands.

It's too early to judge precisely how well this particular relay works—or other static relays, for that matter. It's a safe bet, however, that they will eventually play a featured role in protective relaying. Manufacturer of the static overcurrent relay described is now planning a complete line of static relays.

Potential transformer tames high voltage



HIGH AND MEDIUM voltages are reduced to 120 v for relay input signals



TYPICAL PT is conventional transformer with high ratio, low energy needs

Instrument transformer: relay's partner

Relays that interest us most in this report are not connected directly into the circuits they protect. Instead, they are actuated by signals in the form of currents and voltages, and these signals are *in proportion* to the currents and voltages in the circuits the relays monitor. In nearly all cases the input signals come from instrument transformers. Voltage signals stem from a potential transformer (pt) and current signals from a current transformer (ct).

We use instrument transformers for three important reasons: (1) It is impractical to build relays large enough to handle hundreds or thousands of amperes and to insulate them for kilovolts. (2) We want to insulate the relay trip circuits from the power circuits, both for safety and simply to sidestep primary lines. (3) We can standardize on maximum relay-operating currents and voltages—and this is essential to avoid confusion.

Burden is the external load—principally made up of relays and meters—connected to the secondary of an instrument transformer. A given "load" of relays has its own definite power requirement, small though it may be. The instrument transformer must be able to supply this load, and it's rated accordingly. Manufacturers state the burdens of individual relays, meters, etc; from these, together with the resistance of interconnecting leads, you calculate your total transformer burden.

Polarity (that is, the *relative instantaneous polarity* of the ac quantities being sensed) is important. Therefore, all instrument transformers have one primary and one secondary terminal marked to indicate their polarity relationship, schematics above. At any instant, when current is flowing in the marked primary terminal, current is flowing out at marked secondary terminal. Or, putting it another way and considering direction of current only, you can make connections by assuming the marked secondary is a continuation of marked primary.

Potential transformers may be connected either line-to-line or line-to-neutral on the primary side, depending on their ratings and on the application. Connection of secondary depends on kind of relay function.

The ASA has worked out accuracy classifications for potential transformers (C57.13). For protective-relaying purposes, ratio and phase-angle inaccuracies of ASA-standard potential transformers are so small they can be neglected if the burden falls within the pt's thermal volt-ampere rating. (Thermal va rating corresponds to the full-load rating of a power transformer.)

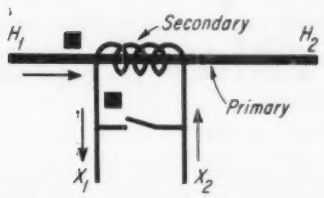
Voltage for relay inputs may come through capacitors instead of pt's, and such capacitors may be built into h-v bushings. But they're rarely used below 69 kv.

Current transformers are designed so variations in primary current produce highly accurate proportional variations in the secondary current. In an ideal transformer supplying a fixed burden, flux produced by the primary current would induce a current in the secondary in proportion to the ratio of turns. Practice never quite lives up to theory, of course; in actual ct's, several factors enter in to produce a small ratio error.

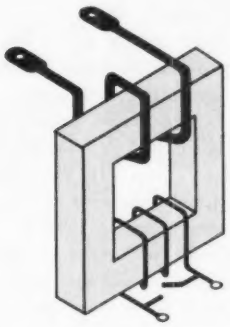
Let's look at some of the peculiarities of a ct. Unlike a power transformer, the ct's primary current is not determined by the burden on its secondary. Instead, it is determined by external conditions in series with the primary. The secondary winding, with its many turns and high impedance, is intended for a rather narrow range of external burden. A ct is designed to operate with the secondary always a closed circuit. Since the opposing secondary amp-turns nearly approach the primary amp-turns, the core flux, which is due to their difference, is small. Thus, as the current in the power circuit and amp-turns in the primary increase or decrease, secondary amp-turns increase or decrease in proportion.

But if the secondary circuit is opened, there are no opposing amp-turns, and so the core is magnetized by the full primary amp-turns. The flux thus increases tremendously. A dangerously high voltage, induced in the open secondary, may break down the insulation or injure personnel. Even if the insulation holds up, excessive core losses and heating and high voltage drop in the primary result. Therefore, the *secondary circuit of a live current transformer should never be opened.* Always short-circuit

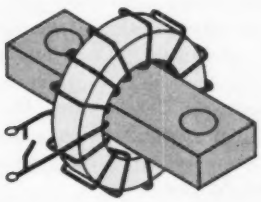
Current transformer makes amperes manageable



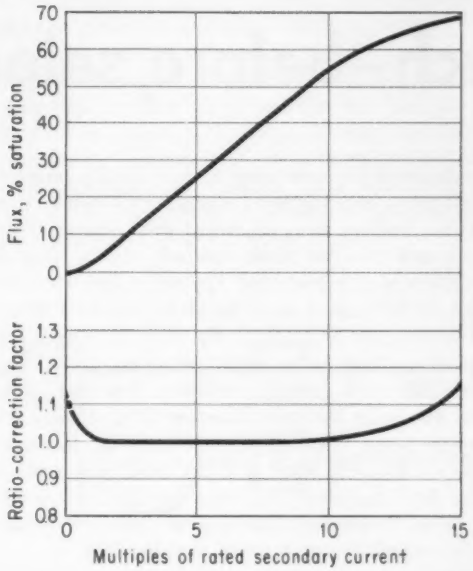
CT RATIO is such that maximum primary current gives 5-amp secondary



WOUND PRIMARIES come in where more than one primary turn is required



DOUGHNUT core-and-secondary is used with a fixed bar, cable or in bushing



RATIO-CORRECTION factor takes into account effect of core saturation on accuracy of input-output ratio

Design of current transformers depends mostly on range of current magnitude and convenience of getting the primary current into the transformer. Smaller currents may require more than one turn for high accuracy. This leads to a wound primary as an integral part of the ct.

For larger currents, a single primary turn is sufficient. This may be an integral bar, or a bus bar or cable with the ct fitted around it. Or the ct may be built around a conductor as an integral part of the apparatus bushings. In some cases, ct's with air cores, called *linear couplers*, perform better overall.

its secondary terminals before you disconnect burden.

Burden rating of ct's was formerly expressed in terms of volt-amperes and power factor. There's a certain logic to that, but it's more accurate to express burden in terms of impedance of the load and its resistance and reactance components, and that is now standard. It's usually enough to add series burden impedances arithmetically. Any inaccuracy will be on the safe side.

Ct's may be connected in wye or delta, depending on application (burden impedances are always connected in wye). With wye-connected ct's, neutral of the ct and the burden are connected together, directly or through a relay coil.

Accuracy of a ct is usually expressed in terms of a *ratio-correction factor:* actual input-to-output ratio is equal to marked ratio times rcf. A rcf curve, above, plots rcf against multiples of primary or secondary rated current. Ct-core saturation is the major influence in ct-ratio error. A rcf curve is calculated for a particular burden; for each burden you will need a separate curve. Manufacturers furnish rcf curves for all ct types.

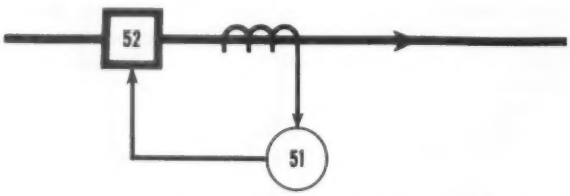
Number of burdens with which you are concerned brings up an interesting point which may complicate matters. At high currents the magnetic circuits of relays begin to saturate, and the burden impedance decreases as the secondary current increases. Therefore you must calculate the ct burden for each value of secondary current for which you want to know the ct's accuracy.

ASA has classified accuracy of ct's; examples might be *2.5H200* and *10L200*. The first term *(2.5, 10)* establishes a maximum percent ratio error. *H* stands for high internal secondary impedance and *L* for low. The third term *(200)* is the secondary voltage the ct can deliver without exceeding its classified ratio error. In practical terms, the ASA classification indicates ct quality. The higher the number after *H* or *L*, the better the ct.

Know kind of protection—and how much—before selecting relay type

We have dissected the basic relay designs from a constructional viewpoint, and (to some extent) looked into their capabilities. And we have examined their necessary adjuncts, pt's and ct's. But what, precisely, can a relay do for us in the way of protection? Protective functions that relays can perform have been listed by *standard device function numbers* in ASA C37.2. On page 79, a table lists condensed definitions of the more commonly used relays, along with their ASA function numbers. Note that in this report we are using the term *function* in a slightly different, wider sense than the ASA definitions. Example: *51N* is an overcurrent relay in a ct's secondary neutral; this is its ASA function. But we consider that, in the broader sense, its primary function is ground fault protection, so we will discuss it under that heading.

Overcurrent protection consists primarily in guarding a component of an electric system against excessive fault currents. To do this, we put a relay in series with the protected element. Relay used, a *51* device, is an "ac time overcurrent relay . . . with either a definite or inverse time characteristic which functions when the current in an ac circuit exceeds a predetermined value." The relay trips a power circuit breaker (a *52* device) which disconnects the protected component.



Overcurrent relays can be adjusted for magnitude of pickup current—that is, the lowest current value at which the relay will work. If relay operates at pickup current without intentional delay, it is called *instantaneous*. Instantaneous overcurrent relays are usually of the plunger or clapper type. They come in a wide variety of current ranges, either as separate relays or as instantaneous elements in combination with a time-delay relay. When the instantaneous teams with the time-delay element, its pickup current is set higher to override the delay element on large fault currents. But the instantaneous trip doesn't operate on moderate fault currents and system current transients, and thus avoids unnecessary shutdowns.

Time delay is usually desirable, either to handle system transients or to coordinate tripping (p 80). System transients, such as motor starting currents or brief overloads, must not trip the breaker. That's why most time-delay relays allow currents several times larger than the relay setting to flow for a limited time.

Time-delay relays are usually induction-disk type (we illustrated them and showed some representative curves on p 70). As a rule, these relays have inverse-time characteristics—they operate faster as current values increase. Overcurrent relays are available with inverse-, very-inverse- and extremely inverse-time characteristics.

The inverse-time relay sees a lot of general service. It is a better choice than either of the others on systems where short-circuit-current levels vary greatly. Reason: its relatively flat time-current curve lets it operate fast over a wider range of short-circuit current.

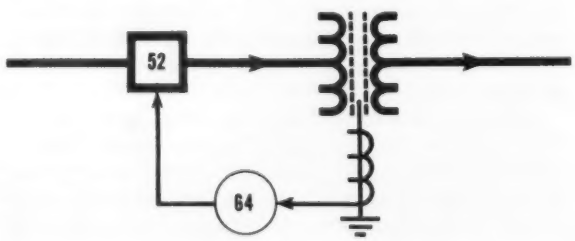
In some relays, operating time after a certain current value is reached is practically independent of current magnitude. These are called *definite-minimum-time* overcurrent relays (curve *C* on p 70). With increasing current values, operating time decreases inversely down to a certain minimum value; then it remains flat.

Since a short circuit will collapse the voltage where an overload causes only a moderate drop, a voltage relay can be combined with an overcurrent relay. This setup means relay will operate at a higher current value when voltage is nearly normal than when the voltage is very low. In this way the relay distinguishes between a fault and an overload. The combination is called an *overcurrent relay with voltage restraint*—we'll say more about it in connection with generator protection (p 84).

Motor-overload protection can be provided in many cases by long-time inverse-time overcurrent relays applied for phase-to-phase fault protection. But their characteristic curve does not approximate the motor's heating curve as closely as the curve of a relay specifically designed for motor-overload protection.

Ground protection, where the industrial-system neutral is grounded and ground-fault current can flow in the line conductors, is usually provided by a *51N* relay connected in the common lead of the wye-connected secondaries of the three ct's. This relay can be set to pick up at much lower current values than the phase relays because only unbalanced current flows in the ct neutral. That is how an arcing or high-resistance ground is detected and de-energized in time to prevent extensive damage.

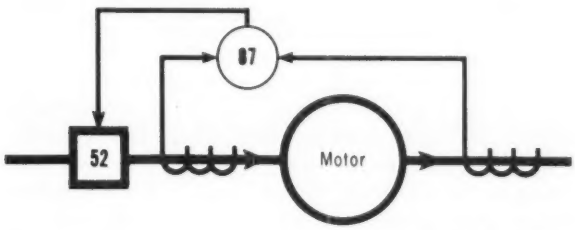
Overcurrent relays for this form of ground protection are generally the same as those used for phase protection, except that a more-sensitive range of minimum-operating-current values is likely to be required. Relays with inverse-, very-inverse- and extremely inverse-time characteristics apply, as well as the instantaneous types.



Transformers and generators with grounded neutrals can be ground-protected by an overcurrent relay hooked up with a ct neutral-to-ground lead. These relays are set at low current values whether or not ground current is limited by neutral impedance or resistance.

A ground protective relay (*64*), by ASA definition, is neither of the above. It's "a device which functions on failure of the insulation of a machine, transformer or other apparatus to ground, or on flashover of a dc machine to ground." This device may be applied to transformers on grounded-neutral systems; then the transformer tank is insulated from ground except for one connection through a ct. Ct secondary energizes an overcurrent relay. This kind of arrangement gives sensitive protection for arc-overs to tank or core, but will not, of course, respond to turn faults or faults in transformer leads.

Differential protective relay (*87*) functions "on a percentage, phase-angle or other quantitative difference of two currents or of some other electrical quantities." For example: If a large motor is wound so both ends of each phase winding are accessible to ct's, we can measure current flowing into each phase and compare it with the current flowing out of the same phase. If the current we measure in these two locations is not the same, we know that current is being diverted by a short-circuit or a ground. Differential relays are set to detect smaller values of current than overcurrent relays, and de-energize the motor before maximum fault current is drawn.

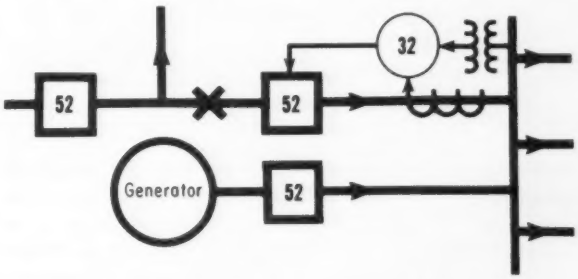


Almost any relay can function as a differential. In other words, it is not so much the construction as the way it is connected into the circuit that makes a relay differential. We'll go into some of these hookups later, p 83. Most extensively used today is the percentage differential relay. Most common construction for this is induction disk, though balanced-beam type has been used. In either case there is an operating coil and a tapped restraining coil which supplies counteracting torque. Percentage differential relays permit more sensitive protection without risking false operation from small differences in ct's current output. Their differential-percentage characteristics range from 10 to 50%. Most differential relays are essentially instantaneous.

As we pointed out, true differential relaying applied to rotating machinery requires two ct's for each phase, so both ends of each phase must be available. But with smaller machines this may not be economically justifiable, and so here current comparison between phases is often a satisfactory substitute for differential protection. In applying these relays, we assume that the normal currents in each phase are equal to each other. Should a fault occur in the motor or generator involving one or two phases, the currents become unbalanced. Then the relay operates to de-energize the machine.

In addition to protecting against winding faults, balanced-phase-current relay guards against damage to the motor or generator because of single-phasing.

Directional relays sense the direction of current or power flow, or of voltage, and operate when the desired direction is reversed. They are usually associated with overcurrent, overpower or overvoltage relays. Ac directional relays are usually a form of induction relay, sensing direction by comparing phase angles between the monitored quantity and a polarizing quantity.



Sketch shows one application of a directional relay. For a fault between breaker No. 1 and breaker No. 2, the generator would feed power through breaker No. 3 and No. 2 to the fault. Fault current might operate overcurrent relays to trip these breakers, shutting everything down. Furthermore, if breaker No. 1 tripped for some reason other than a fault on the load side, and you had no directional protection, the plant generator would feed the outside load. But a directional relay on breaker No. 2 could be set to trip only this breaker. Then the generator could continue feeding the plant's bus.

Ac directional overcurrent relay (*67*) functions "on a desired value of ac overcurrent flowing in a predetermined direction." Its overcurrent unit is practically the same as the plain overcurrent relay. It has the same definite-minimum-time, inverse- and very-inverse-time current characteristics, and you can also get it with voltage restraint on the overcurrent unit.

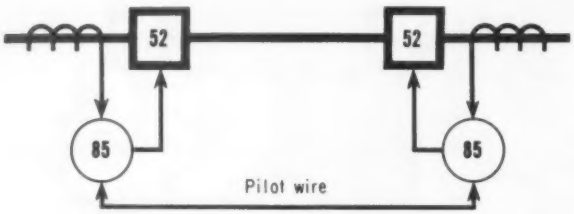
Today's directional relays are usually *directionally controlled;* the directional unit detects current flowing in the tripping direction and activates or releases the overcurrent unit, which is inactive until then.

A neutral-grounded industrial system using parallel feeders or loops may want directional ground relays for protection. These are constructed, in general, like the directional overcurrent relays used in the phase wires. They need a polarizing source (described on p 82).

A directional power relay (*32*) is "one which functions on a desired value of power flow in a given direction. . . ." Built like a single-phase wattmeter with contacts, it operates at predetermined value of power. It is often used as a directional overpower relay, set to operate if excess power flows out of an industrial-plant power system into the utility system. Sometimes it works as an underpower relay, separating the two systems if the power flow drops below a certain value.

Voltage and power directional relay (*92*) connects two circuits on a voltage difference in one direction and disconnects them on a power flow in the opposite direction. This type is used only in large loop-network systems.

Pilot-wire relay protection depends on the interconnection of relays remote from each other. Device *85* is "operated or restrained by a signal used in connection with carrier current or dc pilot-wire fault directional relaying." The industrial uses this type (often referred to as an *87* rather than an *85*) only where a separate auxiliary circuit or ac pilot wire makes the connection.



Relaying of tie lines, either between the industrial and the utility system or between major load centers in the industrial, often brings up a special problem. It is essential that such lines be capable of carrying maximum emergency load currents for various lengths of time, and equally essential that they be removed from service quickly if a fault occurs. Pilot-wire relaying (a modified form of differential) comes in here. This method responds quickly to faults in the protected line, clearing the fault promptly and minimizing line damage and disturbance to the system. But it is totally unresponsive to load currents and to currents flowing to faults in other lines and equipment.

Pilot-wire relaying schemes all depend on comparing conditions at the terminals of the protected line; relays operate to indicate a line fault. The terminal relays operate from their ct secondaries, but the pilot-wire interconnection operates on a small portion of secondary current, has little effect on ct burden. Of the two basic pilot-wire systems, one works on the opposed-voltage principle, other applies the circulating-current principle to the interconnections.

In an *opposed-voltage* system, small samples of secondary current create voltages which are equal and opposite to each other. Therefore, no current flows in the pilot wire under normal conditions. A fault throws the voltages out of balance; the current flows in the pilot wire and operates the relays.

In the *circulating-current* system, the small sample current flows continuously in the pilot wires and terminal directional relays. A fault in the protected zone upsets the pattern of current flow, operating the relays.

Either system provides adequate protection, but one may have special advantages for a particular application. Both systems incorporate necessary restraint, so that ct errors during severe short circuits outside the protected zone won't cause false operation. Most arrangements involve two pilot wires, the 3-phase terminal signals being converted to single-phase. These 2-wire systems may be ten miles long or longer, ample for industrial applications. For long lines, the local telephone company will rent pilot wires. For extra reliability you may install monitoring equipment to continuously check the condition of the pilot wires and warn you if they are short-circuited or open-circuited somewhere along their length.

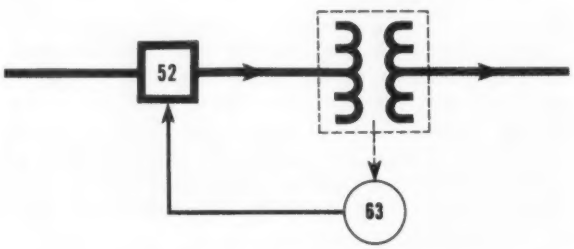
Distance relay (*21*) functions "when the circuit admittance, impedance or reactance increases or decreases beyond certain predetermined limits." It measures line impedance between the fault location and the relay location, which is proportional to line length, and so gets its name of *distance* relay. It applies to long lines, and while it's unlikely to be used within the industrial system, may be used with utility supply in the main sub.

The measuring element is usually instantaneous, but there is a trend toward increased use of inverse-time elements. (Auxiliary timers with constant time values were also formerly used.) A typical transmission application uses three measuring elements in the primary protection zone of the line. It trips the breaker without intentional delay. Second element operates for faults in the primary zone and one adjacent or backup zone; this has a short delay. The third element is set to include a still more remote zone and uses still longer delay.

These relays are most useful where selective instantaneous operation of breakers in series is essential, where changes in operating conditions cause wide variations in fault-current magnitudes, and where load currents may be large enough in comparison with fault currents to make overcurrent relaying undesirable.

Mechanical- or chemical-input is a name we apply to relays which attempt to detect faults in electric equipment by sensing nonelectrical manifestations of the faults. Their chief interest is in transformer protection. Gas- or oil-pressure relays (*63*) attach to the top or side of transformer tanks, where they respond to winding faults which produce gas or sudden pressure waves in oil.

These relays usually have a chamber which collects gas formed slowly as a result of overheating at some part of the winding (perhaps caused by an incipient fault). The relay operates after gas reaches a predetermined value. Rapid collection of gas or pressure waves in the oil, caused by short circuits in the winding, trigger fast operation without need for collecting any given volume of gas. Transformer tank must be shaped so gas rapidly finds its way to the relay's collection chamber. Most transformer tanks suit modern relays.



Another approach to sensing incipient faults in transformer windings: the gas-analyzer relay. This device responds to certain gases characteristically produced by insulation breakdown. It can operate to de-energize the transformer before much damage is done.

Modern forms of these relays with nonelectrical inputs differ from the Bucholz relay, an old standby in Canada and Europe. They are all intended to supplement electrical-input relays, letting you use less sensitive settings

on the electrical-input relays and thus avoid false operation on magnetizing-current inrush.

Frequency relays (*81*) restore a balance between load and generation by automatically dropping less important segments of the load. An appreciable frequency deviation indicates serious system trouble, meaning that generators will be severely overloaded. But if you drop part of the load, you may gain enough time to isolate the trouble without interrupting service to essential parts of the load.

The overfrequency relay operates when system frequency exceeds the value for which relay is set; the underfrequency relay, which is more often used, operates when system frequency drops below its setting. Common frequency relays adjust for operating frequency and time; their speed depends on deviation of actual frequency from the relay's setting. There are other types, actuated by rate of frequency change. Output of frequency relays actuates auxiliary relays to trip appropriate breakers.

Voltage relay functions at predetermined values–undervoltage (*27*), overvoltage (*59*) or a combination of both. Generally it is either a plunger or induction relay; either has settings to permit adjustment of pickup and dropout. Plunger relays are usually instantaneous, but sometimes they use dashpots or other delay devices. The induction relay is always provided with an adjustable time delay and has an inverse-time characteristic (the greater the deviation from the voltage setting, the faster the relay operates). Because system voltage disturbances must sometimes be tolerated for relatively long periods, long-time relays are available.

Standard device function numbers listed in table, right, include those most often used in industrial protective-relaying systems. Full list includes 99 numbers, some of which are spares, not used now but reserved for additional functions which may develop. Other series of numbers are used to relate these same functions to other parts of the system: feeder equipment is designated by the *100* series, *101* corresponding to *1* and used for the same function. The *200* series applies to automatic supervisory equipment used with machines, and the *300* series applies to automatic supervisory equipment for feeders.

Suffix letters tack onto the device numbers for various purposes. Example: *52BT* is a bus-tie circuit breaker. Some letters denote separate auxiliary devices: *R*, raising relay; *L*, lowering relay; *CS*, control switch; *PB*, push-button. Other suffix letters indicate the condition or electrical quantity to which the device responds or the medium in which it is located: *C*, current; *Q*, oil; *VAR*, reactive power. Still others spell out the location of the main device in the circuit or the type of circuit in which the device is used or the type of circuit or apparatus it is associated with: *BK*, brake; *E*, exciter; *N*, network or neutral; *S*, synchronizing; *TM*, telemeter. Parts of the main device may also be indicated: *CC*, closing coil; *S*, solenoid; *TC*, trip coil; *V*, valve.

Contacts and auxiliary switches have letter designations to indicate their position. An *a* contact is closed in energized or operated position (commonly called a *normally open* contact). A *b* contact is closed in the de-energized or nonoperated position (*normally closed*).

Standard device numbers pinpoint relay functions

Device number	Definition and function
21	**Distance relay** functions when circuit admittance, impedance or reactance increases or decreases beyond predetermined limits
27	**Undervoltage relay** functions on a given value of undervoltage
32	**Directional power relay** functions on a desired value of power flow in a given direction
37	**Undercurrent or underpower relay** functions when the current or power flow decreases below a predetermined value
46	**Reverse-phase or phase-balance current relay** functions when the polyphase currents are of reverse-phase sequence, or when the polyphase currents are unbalanced or contain negative phase-sequence components above a given amount
47	**Phase-sequence voltage relay** functions upon a predetermined value of polyphase voltage in the desired phase sequence
50	**Instantaneous overcurrent or rate-of-rise relay** functions instantaneously on an excessive value of current or excessive rate of current rise
51	**Ac time overcurrent relay** has either a definite or inverse time characteristic which functions when the current in an ac circuit exceeds a predetermined value
52	**Ac circuit breaker** is used to close and interrupt an ac power circuit under normal conditions or to interrupt it under fault or emergency conditions
55	**Power-factor relay** operates when the power factor in an ac circuit rises above or falls below a predetermined value
59	**Overvoltage relay** functions on a given value of overvoltage
60	**Voltage balance relay** operates on a given difference in voltage between two circuits
61	**Current-balance relay** operates on a given difference in current input or output of two circuits
63	**Liquid or gas pressure, level or flow relay** operates on given values or on a given rate of change of these values
64	**Ground protective relay** functions on failure of the insulation of a machine, transformer or of other apparatus to ground
67	**Ac directional overcurrent relay** functions on a desired value of excess ac flowing in a predetermined direction
81	**Frequency relay** functions on a predetermined value of frequency —under or over—or frequency's rate of change
85	**Carrier or pilot-wire receiver relay** is operated or restrained by a signal used in connection with carrier-current or dc pilot-wire fault directional relaying
87	**Differential protective relay** functions on a percentage or phase angle or other quantitative difference of two currents or of some other electrical quantities
91	**Voltage directional relay** operates when the voltage across an open circuit breaker or contactor exceeds a given value in a given direction

Successful system design hinges on coordination of each relaying scheme

Relays don't operate in isolation, each as a separate entity. On all but the simplest systems, or where fault occurs close to or at generator leads, at least two protective devices—relays, direct trips or fuses—are in line between any fault or overload and the source. So each relay must be integrated into the overall distribution system; each must operate when called on without keeping other devices on the system from working properly.

Before going on line, the protective devices must be *coordinated* to minimize effects of a fault. That is, devices are selected, or adjusted where adjustment is possible, so that the one nearest the fault operates first. If any device fails to function, the device next closest to the source should open the circuit. In most systems, relays must coordinate with low-voltage direct-acting trips and with fuses. They must be set to operate on minimum current yet distinguish between fault and load current, act in the shortest possible time yet allow a margin for selectivity with other protective devices in series.

Coordination begins with the collection of this data: (1) A 1-line diagram of distribution system showing type and rating of all protective devices and their instrument transformers. (2) Maximum and minimum short-circuit currents possible in each protective device. Study performance of the device under varying operating conditions. Data source is a short-circuit study—described in POWER's special report, *Electrical Distribution Protection*. (3) Starting and maximum-peak-load currents of motors and other equipment. (4) Manufacturers' curves for current transformers. (6) Any special overcurrent-protection requirement—such as the National Electric Code stipulates. (7) Any special utility requirement.

Plot time-current curves of the various devices in series on a single sheet of graph paper, as shown at right. Because curves for protective devices often have complicated shapes, plot them carefully with respect to short-circuit currents. Currents available at different voltage levels should be equated to a common scale—example at right shows two such scales.

Short-circuit currents are reflected through delta-delta and wye-wye transformers inversely as the voltage ratio for all faults: line-to-line, line-to-ground and 3-phase. This is also true for 3-phase fault current passing through delta-wye or wye-delta transformers. With these same winding hookups, a line-to-line fault will draw but 86.6% of 3-phase fault current value. On primary side, 100% of the 3-phase fault current will flow in one phase with 50% of this value in the remaining two lines. So, neglecting the transformation ratio, one relay on primary line will carry 13.4% more current than will flow in the secondary faulted phase. To coordinate correctly, you must allow for this unbalance.

Plot curves progressively as you study each circuit, starting at the end farthest from source. In this way, you can see as you go along whether proposed time-current characteristic of each device coordinates with one on its load side. The curves must not touch each other—but keep the gap between them trimmed fine so breaker times don't become overlong on approaching source.

Instead of single lines, time-current curves of direct-acting trips, m-v fuses and time-delay thermal devices are given as bands. Allowances for performance variations are counted in, so the device will operate somewhere between the boundaries of its band—just where depends on a variety of conditions. Time characteristics of relays, on the other hand, are represented by families of 1-line curves to which tolerances must be added. Most relay curves begin at 1.5 times their minimum pickup value because their performance below that value cannot be predicted very accurately. But if needed, you can usually get curves showing expected time-current performance down to 1.1 times pickup value. An attempt is being made to standardize graph paper for coordination.

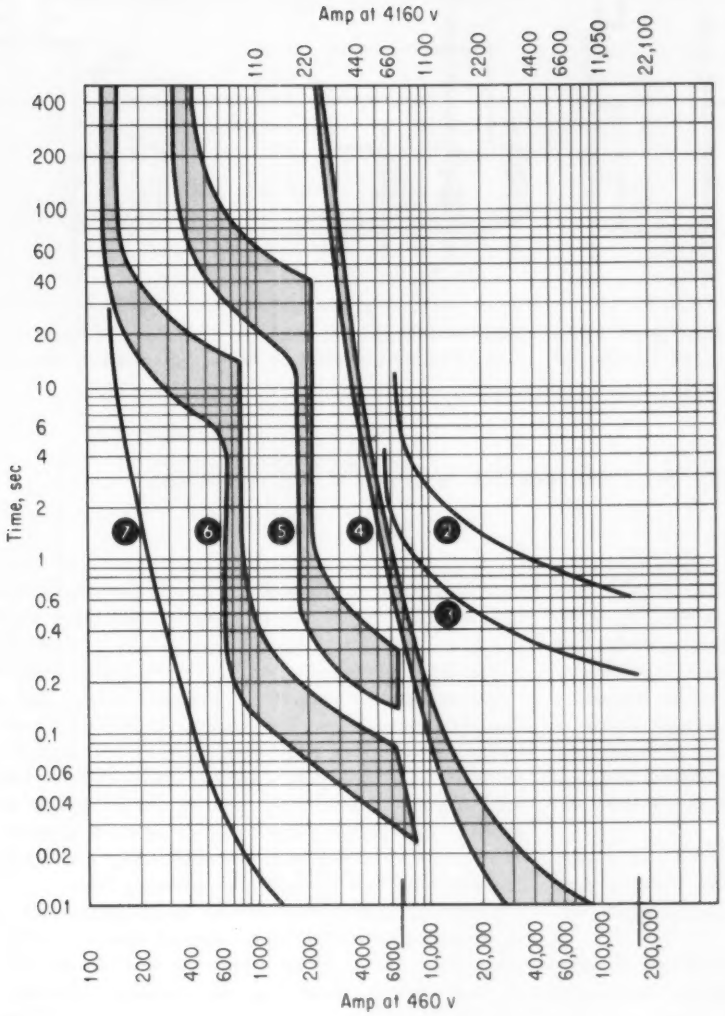
Time margin of 0.4 sec between inverse-time relays in series, when maximum fault current is flowing, should be enough for selectivity. This margin includes the 0.13-sec breaker opening time (eight cycles) and 0.1-sec overtravel. The safety factor of 0.17 sec covers manufacturing variations and inaccuracies in positioning the time dial or lever when setting the relay.

Another point to consider: industrial relays must coordinate with utility relays (*1* in sketch), and you may have added up more time delays than the utility will permit for its breaker. Then you'll have to reduce margin between your breakers. Talk it over with the utility in any case, to decide what coordination will be of greatest mutual benefit.

When selecting current-tap and time-dial settings for induction relays, keep following in mind: two relays in series, set to coordinate at maximum fault current, will always work in proper order on lower values of current if their time-current curves are the same shape and the slower relay has the higher current setting. But if its current setting is lower, operating-time curves of the two relays will cross each other low in the fault-current range. Then the slow-set relay actually jumps the gun on its fast-set partner at all values below the cross.

Instantaneous relays in series are coordinated solely on basis of their current settings. They must be set so relay nearest the source won't trip on maximum asymmetrical fault current safely carried by farthest breaker. Line impedance between breakers in series lends a helping hand in coordination by reducing available sc-current value: a fault between breakers pulls more amperes than a similar fault on load side of farthest breaker.

Transformer impedance usually lets an instantaneous relay on a higher-voltage feeder coordinate with the instantaneous-trip coil of a low-voltage secondary breaker. But ordinary cable lengths don't have enough impedance to fully coordinate instantaneous relays.

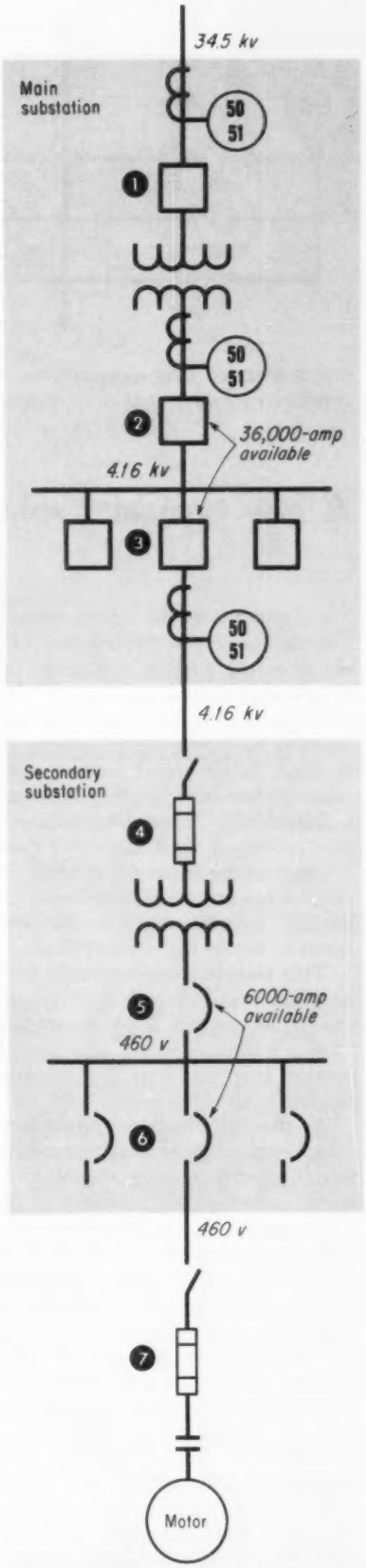


How graphics aid in system coordination

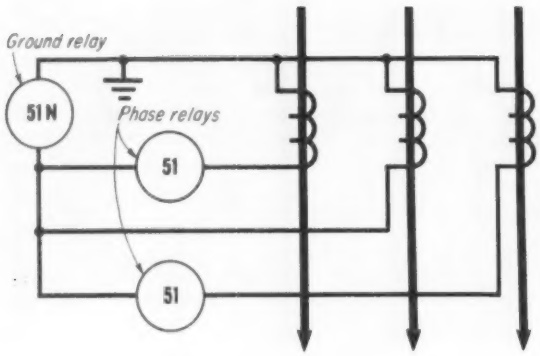
Start plotting coordination curve close to load and work back to source. Fuse *7* protects against fault current from short circuits or grounds in the motor, its controller or interconnections. The controller provides overload protection in this case (a dual-element fuse may also be used for overload protection). Use the smallest fuse that can pass motor-starting current and interrupt available short-circuit current. Circuit breaker *6* is set for a higher current; its time delay keeps it from tripping on faults the fuse should handle. Breakers *5* and *6* get the same available sc current, but their different time settings provide selectivity.

Medium-voltage power fuse *4* protects feeder from transformer faults. Its performance band allows for manufacturing variations, arc-clearing time and fuse damage. Different time settings coordinate relays *2* and *3*. Inverse-time characteristics were chosen instead of the more-inverse types because they coordinate better with fuse *4* in both the high- and low-current regions.

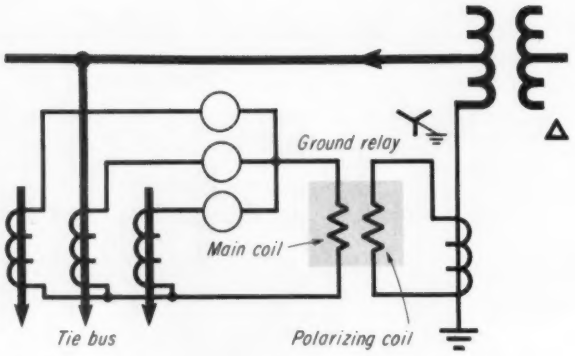
For simplicity, curve for main-sub breaker *1* is left out. But remember, this breaker must also integrate with the system. If it belongs to the power company, obtain its curves and consider utility requirements as you coordinate your protective devices.



COORDINATED protective devices in series work from load back to source



SIMPLE HOOKUP suits many systems. It gives phase short-circuit plus ground protection by relay connected in ct neutral



DIRECTIONAL ground relaying is shown polarized by current value for operation on flowing ground current (arrows)

A few typical hookups serve wide variety of needs

Put together a single incoming-line circuit breaker and a single feeder; add one transformer bank stepping down the incoming medium voltage to utilization level. This is probably the simplest kind of industrial electric-distribution system that needs relaying. On the secondary side you have several circuits with air-magnetic breakers or fuses. In the region between secondary breakers and incoming line (through main bus and transformer), phase and residually connected overcurrent relays are the common protectors, as sketch above shows.

Coordination is simplified when industrial relays have same time-current characteristics as the utility-system devices. Induction types do best with instantaneous elements to handle high-current faults.

This simple system provides both primary and back-up relay protection. A fault on the secondary feeder should be cleared by the secondary circuit breaker (which ordinarily has a direct-acting trip), but if this breaker fails, relays on the incoming-line breaker open breaker to clear the fault.

As the distribution system grows, sequential and interrelated stages of relaying mushroom. Then your protective-relaying scheme should be inherently selective within each zone of protection (p 68).

Protective relaying associated with the main-sub transformer of a large plant is shown at top of opposite page. This plant has utility feed or in-plant generators connected to a synchronizing bus. Each relay plays its individual, important role: Overcurrent relays, inverse-time (*51*) and instantaneous (*50*), protect the transformer primary. A time-delay overcurrent-relay ground (*51G*) connects in the transformer's neutral circuit, while on its secondary side, directional relays apply to both phase (*67*) and ground (*67N*). A differential relay (*87*) protects the transformer still further.

Directional relays keep power from flowing out along the bus if there's a fault in the transformer or its supply line. Directional-overcurrent relays for phase-to-phase and 3-phase faults are single-phase units; three normally go into a 3-phase circuit. Both the directional and over-current-element coils connect to ct's in the line; potential coils usually connect to two open-delta or three wye-wye pt's in a quadrature arrangement (current at unity power factor leads potential by 90 deg.)

Directional-overcurrent ground relays are built like directional phase-fault-protection devices. Operating coil of a directional-overcurrent relay connects in the neutral of the line ct's as shown above. Neither normal load currents in the ct secondaries (even though unbalanced) nor phase-to-phase nor 3-phase short circuits will start current flowing in the neutral; only ground faults cause current flow through the operating coil.

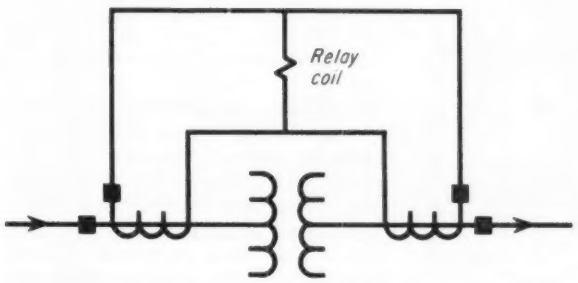
Current-polarizing coil (p 73) is connected to a ct in the transformer neutral where current always flows in the same direction no matter where the fault occurs. Or, instead of a current-polarizing coil, a voltage-polarizing one may be hooked across the open corner of wye-delta-connected pt's with broken-delta secondary. In normal operation the three voltages are equal and there's no potential across the relay coil. But a ground fault immediately sends a voltage across it, with a phase angle corresponding to the angle of the grounded primary phase.

Voltage coils of phase-fault directional relays can be tied to the same pt's with a 60-deg connection (where current at 1.0 pf leads the voltage by 60 deg). Alternate arrangements: wye-wye pt's for phase-fault relays; wye-broken-delta auxiliary transformers for polarizing coil.

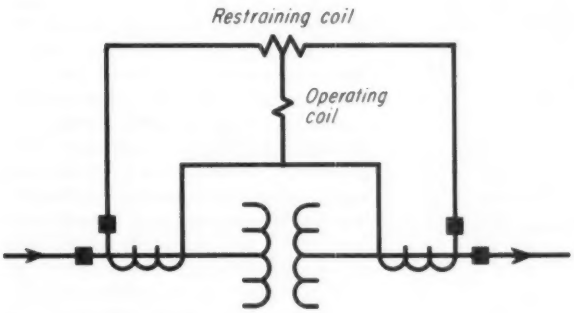
In some designs, directional-overcurrent ground relays have both current- and voltage-polarizing coils; either one may be used. Having the two coils is often a help, because combined effect of two polarizing sources boosts relay's torque, comes closer to guaranteeing positive action on low-current high-impedance short circuits.

Transformer differential relay works on a constant percentage difference between currents in two ct's. Taking their cue from the differential-relay principle, they watch to be sure that when current enters one winding a corresponding amount leaves the other. Two basic differential-relay hookups are shown above; these connections must take into account the transformer ratio.

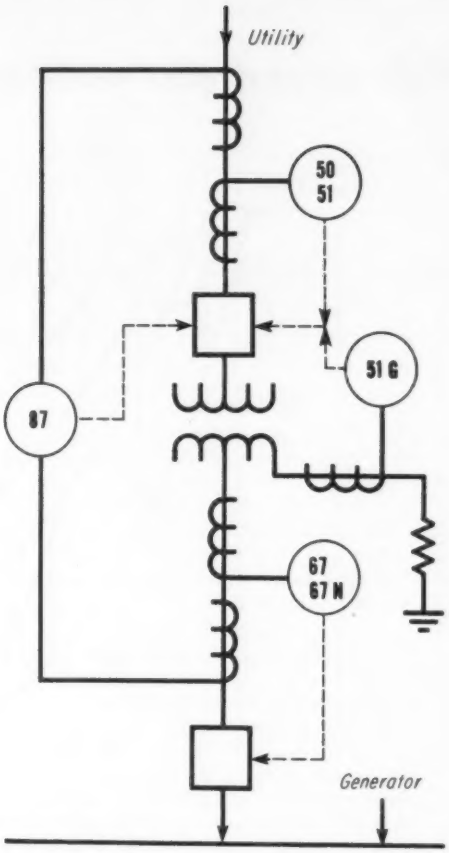
Two common differential-relay hookups



OVERCURRENT RELAY is connected so no current flows through it unless fault occurs between relay's two ct's



PERCENTAGE-DIFFERENTIAL RELAY is connected with operating coil tapped into restraining coil in series with ct's



MAIN-SUB PROTECTION for transformer and incoming line uses overcurrent, differential, directional, ground relays

When large transformers are connected to the line, magnetizing-current inrush sometimes soars 12 to 15 times normal operating magnetizing current. A differentially connected relay responding to current magnitude only must be set high enough in current and time to ride through the magnetizing period—but this reduces protection it can give. To get around the dilemma, a harmonic-restraint feature keeps relay from operating when magnetizing inrush current first hits the transformer.

Harmonic restraint works because magnetizing inrush current's distorted wave form contains mostly second and third harmonic components, not present in short-circuit current. These harmonic components are filtered out and used to restrain the relay, preventing false operation. Harmonic-restraint circuit is kept from blocking relay operation on internal transformer faults—that is, faults severe enough to create substantial third-harmonic current because ac has saturated the ct's.

Another differential relay uses a supplementary tripping suppressor to prevent false operation on inrush current. Suppressor introduces necessary time delay to ride through the inrush period under normal conditions, but also trips immediately on a fault inside the protected zone during the magnetizing period.

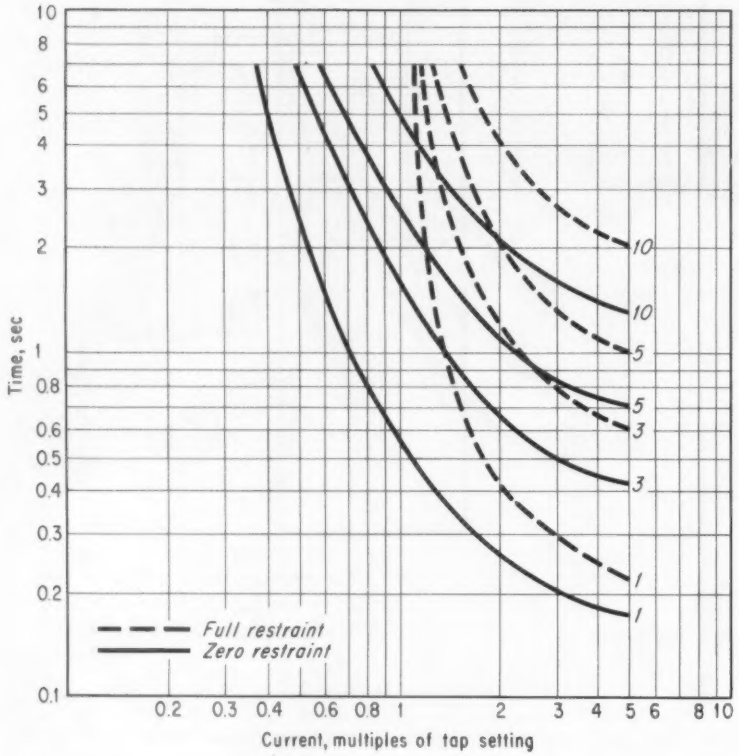
Largest inrush naturally comes when a transformer is connected to the system. But some inrush is possible at another time: when a fault outside the transformer is cleared and voltage returns to normal.

Flow will be moderate because transformer is already partially energized. When a transformer is paralleled with a second energized bank, inrush current of the transformer switched on the line finds a parallel path through the energized unit, and the energized bank can have a sympathetic inrush.

Tap changing brings up an additional problem in differential protection of transformers since current ratios between primary and secondary change as taps are varied. When taps are changed manually at infrequent intervals it is possible to compensate for the ratio change by resetting the relays. Where tap changing is automatic, solution lies in selecting relays with a wider tolerance of differences in the currents compared. True, this solution has its penalty in the form of less-precise protection, but in most cases it is the practical answer.

Differential relays may be classified according to shape of operating-characteristic curves. One works on a constant percentage difference in the two ct's while the other works on a percentage difference that increases rapidly with the sc current. They are often called *constant-* and *increasing-slope* relays, because of shape of their curves.

Voltage restraint modifies relay's response to overcurrent



Overcurrent relay with voltage restraint, described on p 76, was designed especially to protect generators from external faults. Restraining coil lets the relay distinguish between normal operating overloads and short-circuit currents of the same magnitude. A short circuit drops the voltage, cutting the restraining effect and letting relay operate. Relay's sensitivity and speed increase as restraint goes down, reaching their maximum at zero restraint during a 3-phase fault close to the generator.

Amount of voltage restraint depends on type, location and magnitude of the fault. For any time-dial setting, a whole family of curves lies between the zero-restraint and the maximum-restraint curves. So voltage restraint has the effect of modifying overcurrent-relay characteristics. Curves for intermediate values of voltage restraint, falling between the extremes, can be obtained from the relay manufacturer. Relay's taps let you vary current-pickup setting; time dial adjusts to control the operating time for any combination of current and restraint required by the application.

Large industrial power systems often have sectionalizing breakers on their buses to isolate faults in any one bus section. Each section (or the whole bus if it's not sectionalized) can be provided with differential-relay protection to isolate it in case of an internal fault. Bus-protective relay hookups used today include the percentage-differential relay, linear coupler, differential-voltage relay.

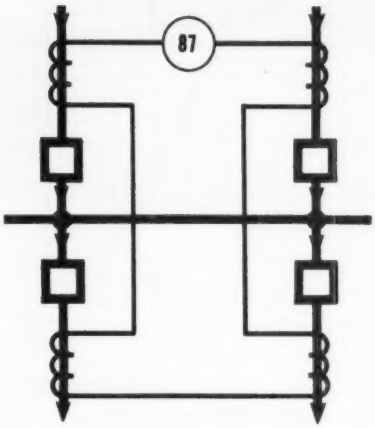
Where relatively few circuits connect to the bus, relays can work on the percentage-differential principle, similar to the transformer percentage-differential relay. Main drawback of percentage-differential relays for bus protection, however, is that all ct's supplying the relays must have the same ratio and identical characteristics. And the problem increases with number of bus circuits. Variation in ct characteristics, particularly the saturation phenomena under short-circuit conditions, challenges this type of protection the most, often limits its application to buses with only a few feeders. One solution: the linear couplers described atop facing page.

Differential-voltage relay, another bus-protection method, uses through type iron-core ct's. To overcome the problem of ct saturation it adds a voltage-responsive (high-impedance) operating coil. Relay connects across the paralleled secondaries of ct's in each of the incoming and outgoing circuits. Normally, the vector sum of these secondary currents is zero: no voltage across the relay coil. But soon as a bus (or external) fault occurs, vector sum is no longer zero and unbalanced current flow produces a voltage drop across the relay. But no matter what the size of bus fault, this voltage is greater than it would be for any external fault, and so the relay is able to distinguish an external from an internal fault.

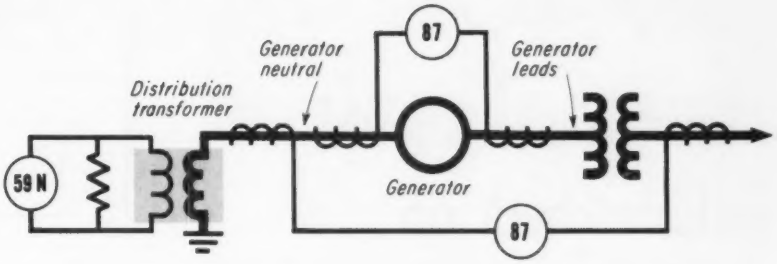
There's no limit to number of source and load feeders to a bus protected by linear couplers or voltage-differential relays. In general, this protection works faster than percentage-differential relays. On the other hand, linear couplers or ct's for differential-voltage relays cannot handle any other duties. You'll need separate ct's for other relaying or for metering.

Tying in with a utility system, when you formerly generated all your own power, brings up a host of new problems. When planning a parallel-operated tie with a utility company, go over entire fault-protection problem including circuit-breaker interrupting capacity. Consider a typical case where: (1) All plant breakers are capable of interrupting the increased short-circuit current. (2) Plant-feeder breakers use inverse-time or very-inverse-time overcurrent relays with instantaneous units. (3) Each industrial generator is protected by differential relays and has external backup protection by generator overcurrent relays with voltage restraint or voltage-controlled overcurrent relays. (4) Utility's end of the tie line will auto-

Consider linear couplers for bus, differentials for generator



Linear-coupler bus-protection scheme eliminates difficulties caused by differences in characteristics of iron-core ct's. Sensitive relay can be used. The linear couplers of all breakers on the bus connect in series. They produce voltages in direct proportion to feeder currents. For normal conditions or external faults, voltages add up to zero. During bus faults, sum of the voltages is no longer zero, but has a value that trips relay.



Unit generation, with generator and transformer closely associated, lets us combine protective relaying. A differential relay across the generator detects internal faults. Another differential relay across the entire unit responds to faults in transformer and generator leads. Ct's at left of the generator connect in each phase ahead of neutral.

Neutral is then grounded through a transformer which provides suitable impedance to ground. A stock transformer, normal for distribution service, also suits this application.

Transformer secondary has a resistor for its load. Current flowing to ground through the generator neutral excites the transformer primary, in turn producing current in the secondary and a corresponding voltage drop across the resistor. A short-time low-pickup overvoltage relay detects ground faults.

This grounding arrangement is on the increase for unit generation. Nonunit generation—no individual transformer—omits the overall differential relay, of course. Here you would probably use different ground protection, such as a grounding resistor and a neutral overcurrent relay (*51G*).

matically reclose following a trip-out. (5) Utility-system neutral is grounded and neutral of one or both plant generators is grounded through resistance. (6) Plant generators are not sized to handle entire plant load; you don't want any power to feed back into the utility system.

Protection for utility end of the tie line might consist of three distance relays or time-overcurrent relays without instantaneous units. At the industrial's end of the tie, directional overcurrent relays should handle phase and ground-fault protection. Reverse-power or underfrequency relays should also be provided, so industrial-plant generators won't overload if utility breaker opens. Since this prevents sustained feedback of power into the utility system, directional overcurrent relays for fault protection in the tie line can be set quite low without risking false operation.

Power-directional relays are instantaneous; if you settle on them you must add supplementary time-delay relays to avoid false operation on swings during synchronization of plant generators.

Reverse-power relay is connected to trip the industrial plant's incoming-line utility breaker together with breakers supplying nonessential loads in the plant, to reduce total load to generator capacity.

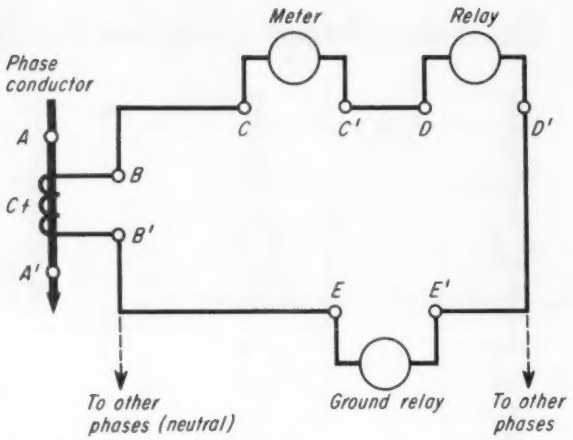
If underfrequency relays (p 79) are used to prevent generator overloading, they'll work the same way to trip incoming-line breaker and nonessential-load-feeder breakers. Sometimes two or more frequency relays are set to operate at successively lower frequencies. Then nonessential load circuits can trip in succession depending on system's load demand.

Generator external-fault protective relays provide primary protection in case of bus faults and backup protection for feeder or tie-line faults that are not cleared by their own relays. These generator relays will also back up the differential relays on internal faults, provided other sources of power feed fault current into the generator. This condition is to be expected.

Relay that opens industrial's incoming-line breaker should be fast enough to open it before utility-company breaker recloses automatically after operating on a fault. Utility end of tie line can be relayed to check that line is dead before re-energizing. This avoids any possibility of tying in with the plant generators out of phase. Safest method calls for utility operator to check with industrial before re-energizing line. In some cases, however, particularly where there are other customers on the same line, advance notice of reclosure cannot be given.

Any proposed relay protection for a tie line between a utility system and an industrial with local generation should be thoroughly discussed by engineers from the utility, industrial user and equipment manufacturer.

Maintenance should include check on ct, trip circuit and relay proper



TYPICAL RELAYING CIRCUIT has several terminals at which continuity, impedance and insulation checks can be made

Protective relays don't fail safe; when a relay reaches the point where it won't operate on a fault, it does not automatically interrupt the circuit it is protecting, as a fuse will. Neither the protective relay nor its associated circuitry gives any obvious indication that it won't work. Only careful inspection (or possibly monitoring) and testing will reassure you that your relay is "alive". Since circuit breakers function only when power is supplied to their trip coils, system protection can be no better than the day-to-day condition of its relays.

Relays and relaying circuitry don't wear much. Their maintenance does not involve any extensive replacement or servicing of parts for that reason, and in this respect it differs from typical practices for rotating machinery or controllers. A relay operates at most a dozen or so times a year, and in many applications may not be called upon more than once in 20 years. So damage nearly always starts outside the relay. Some common causes: (1) Corrosion of metal or deterioration of insulation because moisture has managed to come in contact with relays or associated equipment. (2) Vibration. (3) Tampering by unauthorized or inexperienced persons. (4) Direct mechanical injury. Effects of some of these accumulate slowly. They may not be apparent after one or two years, but could make the relay useless in ten years if left untouched.

Relay maintenance is not complicated, but must be done carefully and requires some understanding of construction and relaying principles. Relay maintenance man must fully appreciate how important the relay is to operation of the plant and safety of its personnel. Maintenance by careless or uninformed workmen is worse than no maintenance at all, since the damage they do is usually more drastic than the effects of neglect.

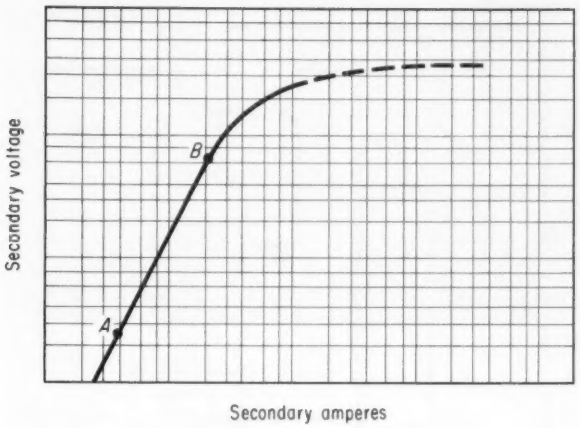
Coordination study is not, strictly speaking, part of a maintenance program, but the two go hand-in-hand keeping the protective system at maximum effectiveness. In an older plant, coordination may require replacing some relays. Keep complete records on the proper setting of each relay in the plant and record any changes made because circuits were added or for other reasons. As you brief a relay maintenance man, supply him with correct settings for each particular relay—and keep your records up to date.

Type of relay-maintenance program you'll go for depends on economics, determined by particular needs of the plant. Larger plants usually find purchasing their own test equipment and training their own men a good investment. But for the many smaller industrials who cannot justify such a program, service organizations will do the testing at a reasonable fee. Service companies are in a good position to get an economic return on their investment in test equipment, so they can use the best available at a low cost per individual relay servicing. Manufacturers and insurance companies, too, sometimes offer maintenance service.

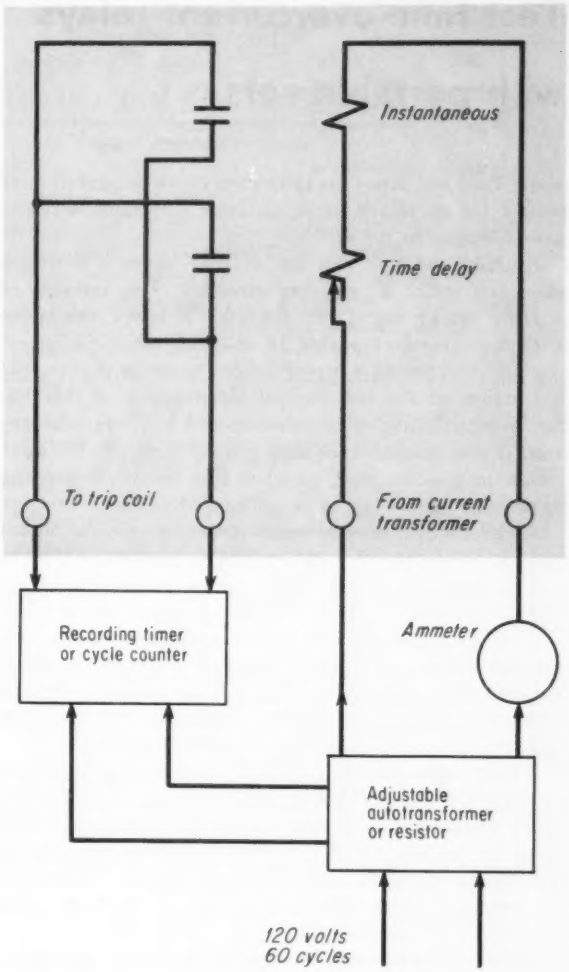
Some service organizations use engineers for the work and others use specially trained shop personnel. Decide at the outset whether you want the technical contribution that outside engineers can make, looking at aspects that are possibly broader than just testing relays. Of course, if a coordination study of the system is required, maintenance will take more time during the first year, resulting in higher cost.

A side benefit of regular relay maintenance, whether done by your own men or outside people, is a check against errors in the original circuitry or in subsequent connections. Fairly often, some incorrect hookup which went undiscovered in the course of daily operation comes to light during a maintenance test.

Frequency of testing depends to some extent on the type of relay function, how critical the relay is to overall system performance, and ambient conditions of cleanliness, average operating temperature, exposure to vibration and shock, quality of operating personnel. Best timing for a given installation will be decided by your own good judgment based on experience—it's likely not more often than six months, nor can it prudently be longer than three years. One year is probably the most common interval in today's well-maintained industrial plants. The ideal is to test frequently enough to detect and repair incipient trouble. Keep in mind, though, that



IMPEDANCE TEST on ct is made by plotting a few points on saturation curve. Deviation from records signals a short



HOOKUP for operational test of typical time-overcurrent relay simulates a faulted circuit. Test-current source: an adjustable-resistance load box or an autotransformer. A timer or cycle counter, working through an auxiliary relay (part of test setup) measures time to close breaker trip circuit after current is applied corresponding to the occurrence of the fault

trouble is not necessarily cumulative; changes in plant operation may change relay's environment and accelerate damage. Or purely accidental damage or tampering may make a relay inoperative. The more frequent test interval will pick out this exception, and so may be valuable even when the general condition of plant relays does not indicate need for maintenance.

Supplement your regularly scheduled tests with special ones made whenever you suspect that the protective equipment may have been damaged. Observant operating man can prevent future trouble by reporting abnormal performance.

Records are an essential part of any relay-maintenance program. In fact, value of many tests lies in comparing them with results of preceding tests on the same piece of apparatus. A record card used by a large industrial is shown on p 89.

Relay testing should always be done with the circuit breaker de-energized. It is true that strong arguments can be advanced for testing relays with the breaker in operation, provided that sufficient backup protection is available. But complete testing—a check on the ct or tripping the breaker from the relay—it not possible under these circumstances, making this kind of test inadequate. If you are serious about relay maintenance, and we have emphasized its importance, you must schedule circuit-breaker shutdown to test relays right.

Layout of protective equipment should provide maintenance ease. Terminals and links in the relaying circuit simplify removing components, attaching instruments and isolating parts of the circuit. Consider color-coding your terminals to simplify testing.

Relaying circuit includes, besides the relay itself, electric components essential to relay performance, and equally (or perhaps more) vulnerable. These are: (1) instrument transformers—ct's and pt's (2) ac wiring between instrument transformers and relays, including any series devices such as meters or auxiliary transformers (3) dc trip circuit (4) batteries. Kind of test and equipment needed depend on how thoroughly you decide to check these relaying elements. Battery maintenance is outside the scope of this report, but let's see what can be done in the other areas.

Typical relaying circuit is shown above, left (we're only looking at one phase; the whole circuit resembles residual connection on p 82). What are the possibilities for applying continuity and impedance tests between the terminals shown? In all positions (except *A-A'*) you can pass current through circuit element only, through remainder of circuit only or through both in parallel. Of course, de-energize the primary conductor before you start these tests.

From position *B-B'* you can make an impedance or excitation test of the ct (with rest of circuit disconnected). Here you apply a variable source of ac voltage to the ct secondary and measure resulting current in the secondary. Test should include at least two points on the saturation curve and preferably a third one slightly

Test time-overcurrent relays with portable sets

above the knee. Keep the saturation curve as part of your record for its relay. Deviation from the curve indicates short circuits in the ct.

Another test you can use at *D-D'* gives a thorough check on entire ac relaying circuitry. This consists of a relay timing test (we'll describe it later) conducted with the secondary wiring to ct's and other equipment normally connected. Current needed to excite the ct: only a fraction of the test current. Importance of this test lies in establishing an accurate record for later comparison; if later maintenance tests give substantially the same values in position *D-D'* as when first recorded, you can figure that entire layout is unchanged.

Make insulation-resistance tests between the circuit elements and ground, and between ac secondary circuits and dc tripping circuits. Tests can be made with a megohmmeter; expect infinity reading if insulation is good.

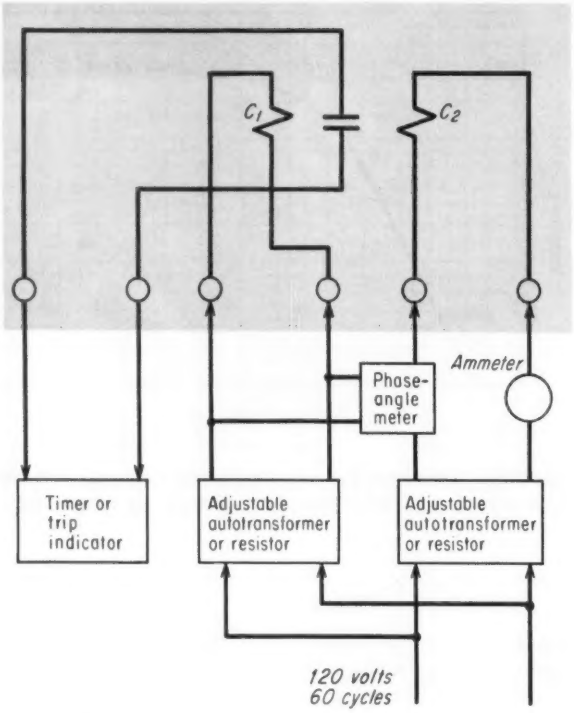
It is also desirable to record resistance of the trip circuit through the breaker's trip coil. Through the years, these readings indicate condition of the circuit; corroded terminals and grounds may be located in this way. You can take the reading with a Wheatstone bridge.

These tests are all valuable ones, but surveys indicate that few plants schedule them regularly. The ordinary plant considers indication of normal potential at the relay adequate verification of circuitry. In our opinion, this is a risky practice. The more thorough tests are justified—at very least the combined relay and ct check for comparison with recorded values.

Relay testing for industrial plants chiefly involves time-overcurrent relays. Typical test setup is shown on preceding page. Before actually attempting to test and calibrate any type of relay, read and thoroughly understand the manufacturer's instruction book covering that particular kind. In most cases, the book will include diagrams showing connections for field testing. Larger companies who have engineers available to prepare specific instructions for testing and maintaining each relay will find such a manual a wise investment. In any case it's a good idea to have data sheets for each particular device available in advance as part of the relay records. Such a sheet might show relay type or model number, identification of circuit it's used with, ratio of ct's to which it is connected, proper current-tap and time-lever settings. It should also leave space to record time to operate at specified percentage of current-tap setting used in the test.

Test equipment in some form is needed to simulate actual operating conditions (ct secondary circuit) and to measure electrical quantities accurately and easily. For the more common relays, all you will need are instruments for measuring time, current, voltage, and some form of loading device. More complex relays may need a phase shifter, phase-angle meter and auxiliary test equipment.

A convenient source of test current is a stepdown transformer controlled by an autotransformer. This type of equipment is required to produce high currents for some relay tests when only low-power service outlets are available to supply the test set. The autotransformer



AC DIRECTIONAL RELAYS are tested to be sure they operate at right phase-angle difference. One load uses phase shifter

greatly simplifies determining minimum settings for all induction-relay types. You can rapidly set instantaneous elements at high currents and avoid overheating the relay. But to do this with resistance loads you must allow considerable time for cooling between adjustments. Also, the autotransformer permits fast adjustment to compensate for poor voltage regulation of the power source, a problem in many substations.

Today you can get test sets combining in one portable case an autotransformer load device and all instruments necessary for most relay tests. Sets come in various ratings. Their advantages have led to wide adoption by industrials and service companies.

Any autotransformer device has this disadvantage, compared with a resistance load: it may produce distorted wave shape. Not a problem with the majority of relays, this is important with some. The manufactured test set just mentioned, in itself, produces pure sinusoidal wave form at all operation ranges. Because of unit's low-internal-impedance design, however, wave deformation produced by saturation in certain relays under test can affect the overall test-set circuit. But even in these cases, deviation is always consistent and you can compensate for it when examining the test results. Then establish a calibration curve for any desired tap of the relay, giving relationship between the manufacturer's time-current characteristics and time obtained with the loading device, accounting for relay saturation. After establishing this curve you can use it as an accurate reference on all subsequent maintenance checks.

Check time to trip at given tap settings to see that

Detailed records serve as basis of later tests

Form at right illustrates one company's method of initiating and recording coordination studies and relay testing (discussed in detail in *AIEE Transactions*, Vol 78, 1959, pp 1-10). Form divides into four parts as shown, and on the reverse side is a block reserved for a circuit sketch and space for remarks.

Plant equipment data is filled out by plant personnel and includes information the engineer needs for his short-circuit and coordination studies. *Load data* is completed at the same time if possible; it gives the engineer valuable data for his coordination work. *Coordination data* is filled in by the engineer doing the coordination study. He records the new relay settings here. *Test* is the final phase of the work, filled in by the engineer doing relay testing in the field.

Circuit diagram on reverse shows circuit elements needed for short-circuit and coordination work if the 1-line diagram is not sufficiently detailed. When work is complete, a typist transcribes original sheet for the final report. Original is then filed in the general engineering office.

Test part of sheet is an outline for the actual relay testing; various blocks are checked as they are completed. Block marked *safety* is checked only when tester is sure the areas in which he works are safe for himself, those working with him, anyone in the vicinity. *Clearance* block is checked when authorization is received to work on the relay.

POWER PROTECTIVE RELAY TEST SHEET

ENGINEERING DEPARTMENT
ENGINEERING SERVICE DIVISION

PLANT: PLANT X

CIRCUIT: POWER HOUSE, 11.5 Kv., FEEDER #103

PLANT EQUIPMENT DATA

RELAY

Type: CO — Mfg — G. E. ☐ West. ☒
Taps: 4 | 5 | 6 | 8 | 10 | 12 | 15
Ins Range: 10 – 40 — C. T. Ratio: 600 | 5
Opn. Ind: 0.2 amps. — Contactor: 2.0 amps.
Ins Opn Ind: 0.2 amps. — Voltage:
Curve: D.T. - 2 sec. — P. T. Ratio:
Style Number: 1338767 — Instructions No.: I.L. 41-280
Remarks:

AS FOUND RELAY SETTINGS

Tap: 6 — Time Lever: 5
Instantaneous: 21.5 | 20.0 | 22.0
Remarks: GASKET DEFECTIVE-EXCESSIVE DUST IN RELAY

BREAKER

Type: 828B — Mfg.: WEST.
Continuous Current Rating: 1200
Voltage: 15,000 — Trip Coil Current: 2.0 amps.
Type of Trip: D-C, 125 VOLTS

LOAD DATA

Primary Current: A 480 B 465 C 473 — Primary Voltage: A 11.2Kv. B 11.2Kv. C 11.2Kv.

COORDINATION DATA

REPORT

Title: PLANT X COORDINATION STUDY
Report No.: EO-433-6
By: TEL — Date: 12/3/57
See Coordination Sheet No.: 10
Remarks:

NEW RELAY SETTINGS

Tap: 4 — Time Lever: 3½ — Ins.: 14.6
400% Test-Amps.: 16 — Sec.: .75
Test Point-Amps. — Sec.
Remarks:

TEST

Authorized by: F. CAREY — Dept.: ELECTRICAL

	Top	Bottom	
Location	TOP	BOTTOM	
Phase	1	3	
Serial No.			
Safety	☒	☒	☐
Clearance	☒	☒	☐
Dust	☒	☒	☐
Clean Trip Ckt.	☒	☒	☐
Burnish Contacts	☒	☒	☐
Iron Filings	☒	☒	☐
Tap	4	4	
Tight Screws	☒	☒	☐
Loose	1	5	
Zero Adj.	☒	☒	☐
Time Lever Setting	3.5	3.5	
Opn. Ind. amps.	.16	.16	
Cont. amps.	1.5	1.6	
Ins. Ind. amps.	.16	.18	
Cont. amps.	1.5	1.6	
Minimum Setting Test	☒ 4 amps.	☒ 4 amps.	☐ amps.
400% Test sec.	.85	.83	
400% Test After Adj. sec.	.76	.75	
Test Point sec.			
Time Lever After Adj.	3.2	3.25	
Instantaneous Setting amps	14.5	14.8	
Insulation Resistance	☒	☒	☐
Relay Case	☒	☒	☐
Trip Ckt. Ω			
Bkr. Opn.	☒	☒	☐
Ins. & Cont. Lock	☒	☒	☐
Gasket	☒	☒	☐
Polarity Check	☐	☐	☐
Cover & Reset	☒	☒	☐
Primary amps.	485	479	
Sec amps.	4.1	4.0	
Seal	☒	☒	☐

Upper pivot bearing was corroded

Iron filings in magnets, reset lever failed to reset opn. indicator

Test Engineer: JAMES C. LIONAL — Assisted by: S. X. LYNN — Date: 1/17/58

Sheet No. 57

relay matches established curve (published by manufacturer or previously determined by test). Two or three points are desirable, including the proposed setting point. But some testers believe just one point will do, such as 400% of minimum test current, unless some point on the curve is critically close to the characteristic of another protective device.

If test shows your relay doesn't operate in correct time for the prescribed time-lever setting, adjust the level until it does. Then record the new time-lever setting.

Instantaneous trips are usually set at several times the relay tap value, and then settings are made directly from values shown on test instruments. It's OK to use same equipment you used to test time-delay elements.

Circuit breakers should be tripped from the relay, and it's preferable to operate relay by test-source current. If you can't trip the breaker when testing relays, schedule a trip for it at first opportunity. Close relay contacts by hand if you can't do it any other way.

Take a careful look around while you're testing. You may discover mechanical difficulties in the relays, as well as defective gaskets, cracked cover glasses, corroded terminals and accumulations of dirt. File down relay contacts with a fine file if they're burned or scored, or burnish them if they're tarnished, but don't use abrasive cloth or paper on these delicate components.

Some plants make a practice of sealing relays after testing and data-recording are finished. You can use conventional meter type lead seal and press. Dies should indicate tester's designation and current year.

Protective relaying: What's ahead?

In this report you have the fundamentals of protective relaying. It is not a particularly complicated or obscure branch of electrical engineering. At the same time, it is a subject that many engineers should know better. Protective relaying is a form of insurance. Like any policy, it may not be fully appreciated until the day of emergency—but when the emergency comes, it had better be standing by.

Unlike motors, controllers and transformers, protective relays do not immediately indicate deterioration, misapplication or improper adjustment. Only when a minor feeder fault shuts down the whole plant, or what is worse, extensive damage is done because a relay didn't work at all, does relaying stand forth in its full importance.

In time to come, industrial electrical engineers will be increasingly aware of the important role protective relaying plays in the efficient and safe operation of their electric-distribution systems. Industrial and Commercial Power Systems Committee of AIEE has recently begun to form a new System Coordination and Protection Subcommittee. And as engineers recognize relaying's growing importance, they will persuade management that it is one key to uninterrupted production.

Three courses of action are shaping up in the search for generally better protective-relaying practice:

(1) Industrials must begin coordination studies and build up effective relay-maintenance programs. Such programs should start with training electrical engineers and technicians in the art of relay operation and maintenance.

(2) Consulting engineers should be encouraged to extend their practice to coordination studies and to preparing specific relay-maintenance procedures for clients' plants.

(3) Qualified service organizations should offer a combined service of system survey and periodic relay maintenance—a special help to smaller plants who cannot justify training and equipping their own men.

What future developments can we expect in the actual design of relays? It seems likely that solid-state devices will come more and more into their own as time goes on—not so much because they are superior in some ways to conventional electromechanical relays, true though this may be, but as part of a general trend in industrial control and integration with computer equipment. As a matter of fact, relays available today have no significant drawbacks for any industrial application if they are selected carefully and given proper attention (same cannot necessarily be said for low-voltage direct trips).

Barring some unforeseeable breakthrough in the labs, no entirely new approaches to protective relaying are in the cards. Present technology is likely to be with us for a long time to come. Our job: understand it and apply it wisely.

Here's further information on . . .

Relaying

The Art and Science of Protective Relaying, by C R Mason. John Wiley & Sons Inc, New York. $12.00

Applied Protective Relaying. Available from Westinghouse Electric Corp, Relay Department, Newark, N. J. $3.00

Protective devices and fault calculation

Electrical Distribution Protection. A 32-p POWER special report published in June 1958. Reprints available. $1.00

Electric Power Distribution for Industrial Plants. Publication No. 952. Available from AIEE, New York. $3.50

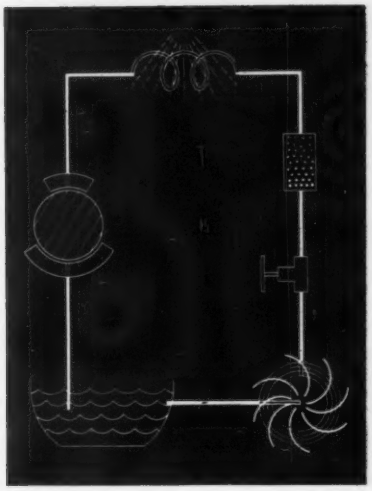
Industrial Power Systems Handbook. Edited by D L Beeman; published by McGraw-Hill Book Co, New York. $15.00

System planning

Today's Electrical Practice. A 52-p POWER special report published in October 1953. Reprints available. $1.00

Electric Power Distribution for Industrial Plants and **Industrial Power Systems Handbook,** listed above

Reprints available Reprints of this 24-p special report are available. Write to Reader Service Department, POWER, 330 West 42nd Street, New York 36, N. Y. There is a charge of $.75 for single copies. Discount on quantities: 10 to 99, 10%; 100 to 999, 25%; 1000 and over, 40%



By E R BOOSER and D A SMEATON, General Electric Company

PIPING for circulating-oil lube systems

Pipes are the arteries that connect all lube-system components. Their design is a critical compromise between excessive first cost and high operating cost—with adequate drainage still another consideration

In first two parts of this series, we looked at basic system characteristics (April POWER, pp 69-71) and then dealt in detail with oil-reservoir design (June, pp 98-100). Now we come to the interconnecting piping—the arteries and veins that tie the whole system together. First, piping carries oil from the reservoir to the pump, coolers, filter and bearings; then it takes the lube back to the reservoir to be used again. Details of a system, of course, will differ widely depending on application, but many design considerations are common to all.

Pipe size comes first. You want to select a pipe large enough to prevent cavitation in pump-suction lines, avoid excessive pressure loss or temperature rise in feed lines or backup in drain lines. But at the same time, you want the smallest pipe practical for low first cost and economical use of space available for the lube-system complex.

Chart 1 on next page shows range of good practice for both feed and drain lines. Velocity is the criteria here—feed lines usually operate at 5 to 10 feet per second. But velocities up to 20 fps are sometimes possible with very light oils, and high velocities are also used to keep contaminants from separating in transit. On the other hand, where heavy oil must be carried long distances, very low velocities—below 5 fps—prevent excessive pressure loss.

Drain lines usually are designed to run about half full, so viscosity, flow rate *and slope* govern their size. About 1 fps is standard full-pipe velocity for light turbine oil, when pipe slopes 3/16 to ¼ in. per ft toward the reservoir. This flow velocity corresponds to 2 fps for a pipe running half full. To get proper drain-pipe size, pick your oil's viscosity from chart 2; pipe diameter is then given in chart 3, which is based on equation (1) in table C, next page. This drain size will operate half full for a slope of ¼ in. per ft of length. But watch out for oil temperature when you're sizing drain lines: during a cold start, the more viscous oils are likely to back up in the drain lines.

Suction pipe to the system circulating pump should be sized to give 3- to 5-fps oil velocity, a range which will avoid turbulence and minimize possibility of cavitation. To keep pressure drop low, make suction line as short and direct as possible. Best solution of all: locate circulating-oil pump right inside the reservoir whenever you can.

Pressure loss is the next consideration. In the usual circulating-oil system, main pump discharges at about 25 to 50 psig. Then, taking into account pressure drop in the cooler, filter and piping to the bearings (with pressure-reducing orifices), delivery pressure at the bearings usually ranges between 10 and 20 psig. Thus, delivery pressure equals supply pressure less corrections for friction loss through cooler, filter and piping, and corrections for elevation difference—equation (2). Here the h terms

A—Start with standard pipe dimensions

Nominal pipe size, in.	Pipe OD, in.	Pipe ID, in. Schedule 40 (standard)	Schedule 80 (extra heavy)	Schedule 160
½	0.840	0.622	0.546	0.466
¾	1.050	0.824	0.742	0.614
1	1.315	1.049	0.957	0.815
1¼	1.660	1.380	1.278	1.160
1½	1.900	1.610	1.500	1.338
2	2.375	2.067	1.939	1.689
2½	2.875	2.469	2.323	2.125
3	3.500	3.068	2.900	2.626
3½	4.000	3.584	3.364	—
4	4.500	4.026	3.826	3.438

B—Allow for flow through fittings

Fitting	Equivalent length in pipe diameters
90-deg elbow, standard radius	32
90-deg elbow, long radius	20
180-deg return bend, medium radius	50
Standard tee	70
Gate valve, open	7
Gate valve, half open	200
Globe valve, open	300
Angle valve, open	170

C—These are the formulas you'll need to use

To find minimum drain-line slope (running half full):

$$s = 0.015\ \frac{Q\,\gamma}{d^4} \qquad (1)$$

To find pressure correction for elevation differences:

$$p_2 = p_1 - \frac{\rho\,(h_2 - h_1)}{144} - f \qquad (2)$$

Reynolds Number shows character of flow:

$$R = 7740\ \frac{V\,d}{\gamma} = 3160\ \frac{Q}{\gamma\,d} \qquad (3)$$

Friction drop for laminar flow (R less than 2000):

$$f = \frac{V\,\rho\,\gamma\,L}{93{,}400\,d^4} = \frac{Q\,\rho\,\gamma\,L}{229{,}000\,d^4} \qquad (4)$$

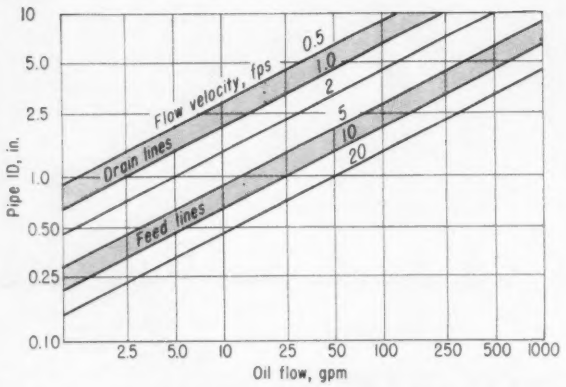
Friction drop for turbulent flow (R more than 2000):

$$f = \frac{L\,\rho\,V^{1.8}\,\gamma^{0.2}}{21{,}600\,d^{1.2}} = \frac{L\,\rho\,Q^{1.8}\,\gamma^{0.2}}{107{,}500\,d^{4.8}} \qquad (5)$$

To find bearing orifice area you need:

$$A = \frac{Q}{300\,C}\sqrt{\frac{\rho}{(p_1 - p_2)}} \qquad (6)$$

Where: A = orifice area, sq in.
C = orifice coefficient. This starts at about 0.61 for a thin square-edged orifice and ranges up to 0.80 for a thick-walled orifice
d = pipe inside diameter, in.
f = friction loss in piping, psi
h_1 and h_2 = static elevations, ft
L = equivalent pipe length, ft
p_1 = upstream pressure, psig
p_2 = downstream pressure, psig
Q = oil flow, gpm
R = Reynolds number (dimensionless)
s = drain-line slope, in. per ft
V = flow velocity, fps
γ = kinematic viscosity, centistokes (from chart 2)
ρ = oil density, lb per cu ft (usually about 53)



1 Since feed and drain lines usually operate within rather narrow velocity ranges, this chart gives a first approximation

represent elevations at points 1 and 2 in ft; f = total friction loss in the system (piping, coolers and filters) for oil of ρ density (lb per cu ft) flowing from point 1 to point 2.

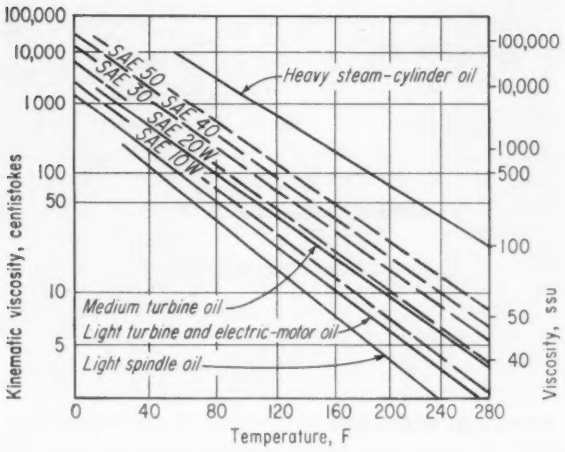
To get friction loss f, first calculate the Reynolds Number. A low number shows low flow velocity with a streamlined laminar character; high Reynolds Numbers are associated with turbulence. Break-even point for our purposes comes at $R = 2000$. To get your Reynolds Number, use equation (3). Then, depending on whether it falls below or above 2000, use equation (4) or (5) to solve for actual friction drop.

To compensate for valves and fittings in your system, use the equivalent lengths in table B and add them to actual pipe length—at a very rough estimate, these valve and fitting losses extend the actual length by at least 20%. Then add friction drops at rated flow through coolers and filters. Filter loss may range from 2 to 3 psi in a new unit, but be sure to cover the loss you expect to have before you clean or replace—which can go as high as 15 psi. A 6- to 15-psi drop is common for many oil coolers. Lastly, add a safety margin of 10 to 15%.

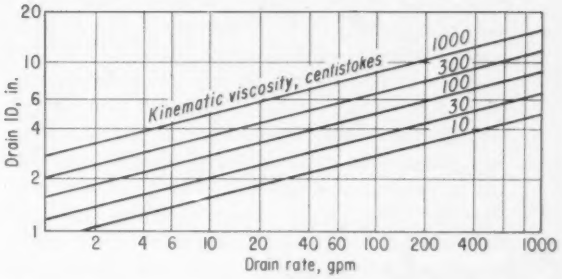
Example: A 150-gpm supply of 130-F light turbine oil at 25 psi is required for a bearing header 20-ft above the oil reservoir. Feed line consists of 35 ft of pipe with five long-radius elbows, one tee and a gate valve. A cooler in the line operates with 8-psi loss at rated flow of 150 gpm. What pipe size should you use with a 50-psi supply pressure?

For 150-gpm feed, chart 1 suggests a pipe ID of 2½ to 3½ in. With this light turbine oil you'll think in terms of schedule-40 standard 2½-in. pipe (ID = 2.469 in.). Reynolds Number from equation (3) is 11,300 for the 17-centistoke oil viscosity (chart 2). From table B, you can figure a length of 36.5 ft of pipe as equivalent to losses through fittings and valve. Add this 36.5 to the 35 ft to get total equivalent length of 71.5 ft.

Since Reynolds Number is above 2000, turbulent flow



2 Oil viscosity at operating temperature plays an important role in determining pipe size. Common oils are covered here



3 Drain lines are usually designed to run half full with a slope of about 0.25 in. per ft. Oil viscosity affects size

exists. So use equation (5) to figure friction drop in piping. Answer here: 6.8 psi. Elevation loss, from equation (2), comes out to 7.4 psi.

Delivery pressure then is supply pressure of 50 psig less elevation loss (7.4 psi), piping loss (6.8 psi) and cooler loss (8.0 psi), equaling 27.8 psig.

If you used 2-in. pipe, delivery pressure would drop unacceptably below 25 psig (actually figuring out to about 20 psig) so the 2½-in. pipe you originally figured is right for this service.

Orifices in lube-oil piping serve two purposes: (1) They control rate of oil feed to individual bearings and other lubrication points. (2) They prevent catastrophic loss of pressure and subsequent starvation of all bearings if a single component fails. Orifices may be located either at bearing inlets or at the exits from the main supply header.

Use equation (6) to figure orifice area, substituting appropriate upstream and downstream pressures and required throughflow. Circular orifices are usual for simplicity, but sometimes other shapes may be desirable. For instance, a long, narrow orifice can be formed as a clearance between two bearing components or as an integral part of a bearing housing. This elongated hole has another advantage—it is less likely to become completely clogged with dirt. If you run the danger of plugging by foreign matter, install screens in your oil lines just upstream of the orifice. In general, some excess oil flow is preferable to using capillary-sized orifices which are susceptible to plugging.

Materials for circulating-oil lube systems should generally be cast iron, carbon steel, stainless steel or aluminum. Bronze fittings and brass cooler tubes are acceptable, but avoid copper tubing and pipe because they accelerate oxidation of the lube oil. Lead, zinc and cadmium, too, promote oil deterioration, so they should be avoided except in the bearings themselves.

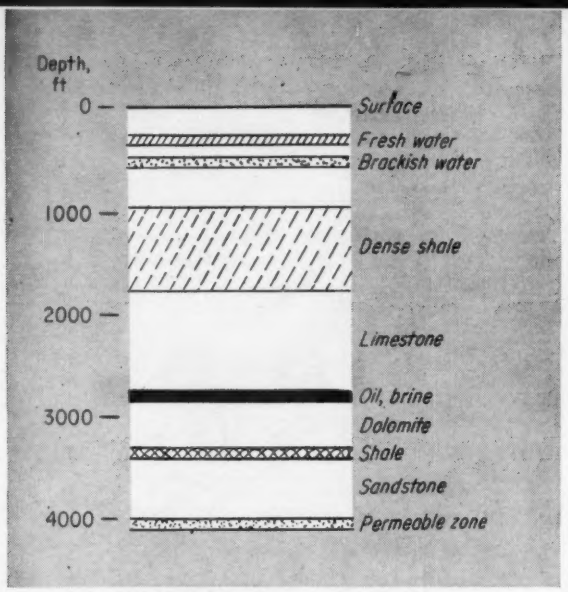
Schedule-40 piping is common unless you're up against a case of extreme vibration or high stress or shock. Larger systems sometimes use schedule 80 for its physical strength. In systems combining both lubrication and hydraulic operation, high pressure occasionally requires schedule 160. A design safety factor of 8 based on operating pressure is average when you're considering pipe-wall thickness. Cold- or hot-rolled seamless pipe is desirable; avoid butt- and lap-welded pipe, especially where they would meet hydraulic-system pressures. Threaded pipe and fittings are acceptable with moderate-sized piping, but welded joints with flanged fittings are preferable for large or critical systems. In any case, all piping material should be carefully cleaned before and after fabrication.

Supports and hangers may be necessary to prevent pipe sag and overstressing of joints; when piping is over 3-in. size, use adjustable supports to distribute the load over a number of hangers. Always consider the possibility of vibration, even in a simple system—this means that each hanger in the system should provide for locking after it's been installed.

Thermal-expansion problems are minimum in indoor installations—piping bends usually permit any slight movement that's required. But in most locales, out-of-doors ambient temperatures show wide variations and you may have to allow for them specially.

If piping can be made an integral part of the machine being lubricated, many benefits are possible. Take another look at the gas turbine pictured in part 2, June 1961, p 99. Here feed lines to bearings follow channels enclosed in the base plate to their positions beneath the bearing housings. Oil drains back in a larger return line which encloses the feed pipe, empties into the original base channel and through it drains back into the reservoir. In this way, all feed lines are protected against the possibility of leaking oil striking hot turbine surfaces where it might catch fire. And the machine looks neater, as well.

Later installments in this lube series will cover additional system components and control and maintenance.

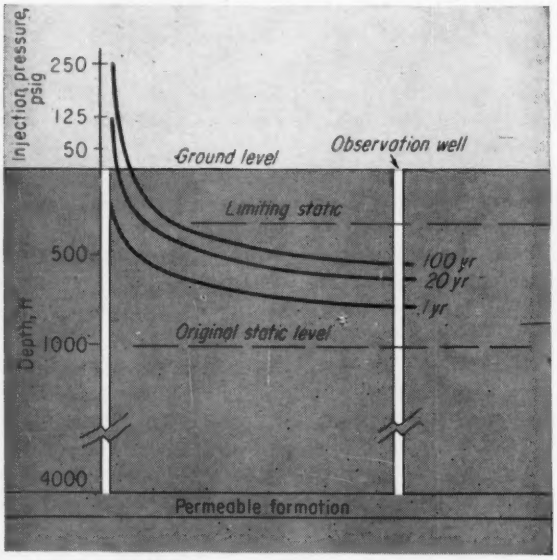


PERMEABLE FORMATION at 4000 ft is excellent disposal zone. 800 ft of impermeable shale protect fresh water at 300-ft level

Check on deep-well disposal for specially troublesome waste

When you have concentrated liquids, poisonous or odorous, to get rid of, deep wells may be the answer. But first you must check local geology and economics to be sure the system will pay out for your plant

By Dr T J POWERS and C W QUERIO
Dow Industrial Service Division



STATIC WATER LEVEL, originally at 1000 ft, stays below 500 ft even after 100-yr operation; pumping head goes up to 250 psig

Since the early 1930's, it's been common for oil fields to dispose of their brine by pumping it into deep wells. But the technique is not widespread elsewhere in industry. Nevertheless it is worth studying where concentrated, toxic or odorous wastes (radioactive wastes, ammonia-still liquor, brine) are produced in an area of limited stream flows or strict regulation. And today's advancing process industries must cope with more and more liquid wastes of this type.

An 11,400-ft well at the Rocky Mountain Arsenal is now down within 400 ft of design depth. Last drilling was through some 1300 ft of a Fountain formation containing fractured zones with suitable porosity. Final drilling to design depth is expected to take full advantage of this formation and terminate at undisturbed graphite.

Deep-well disposal in itself is quite simple. You merely pump your waste down a deep hole, below any useful ground water, and let it diffuse into the ground. However, when thinking about deep-well waste disposal, there are two basic factors for you to consider in detail. The ground must be right before you can pump into it, and wastes must be concentrated.

Geological formations beneath your plant are the first factor. Normally this is something over which you have no control—unless you're building a new plant. If you are, and contemplate deep-well disposal, geology will probably form a part of your plant-location studies.

By "deep" well, we mean a well sunk anywhere from 900 to 12,000 ft. You will need to determine the depth that must be reached to insure

Here's a typical deep-well-disposal job

This is the sort of study you need to determine feasibility in a specific area. Geological findings, left, indicate a brine-bearing formation at 4000 ft which has all the requisites—30 ft of permeable formation with 10% porosity. There are 800 ft of impervious shale from 1000 to 1800 ft; deepest fresh water is at 300 ft. Below this there are some brackish-water and sour-oil zones. Static level of water in the proposed waste-disposal area is 1000 ft below ground level.

In using this permeable zone for disposal, two important factors which may be used as control points for evaluation in planning are: (1) the allowable distance of expected frontal advance and (2) permissible rise in reservoir pressure.

If we establish that we don't want our waste to travel more than one-half mile in any direction, the displaceable volume becomes 0.786 sq mi x 30 (ft of permeable formation) x 0.10 (porosity percentage) = 65.6 x 10^6 cu ft. This amounts to 490-million gal. With an assumed waste flow of 40 gpm, displacement time is 8500 days or 23.3 years. If the waste can be concentrated to reduce volume, displacement time is correspondingly lengthened. And if we can use a radius of one mile instead of one-half, time of displacement will approach 100 years —well beyond planned life of any modern industrial installation. But the one-half-mile limitation is typical, and it's probably something over which you have no control—dictated by local regulations.

that the well passes *through* an impermeable formation or cap rock and extends *into* a permeable or porous formation that can absorb the waste liquid. Nature rarely distributes permeability and porosity uniformly. But you must have a pretty good idea of their distribution when analyzing a given locality for deep-well disposal.

The more detailed the information you can gather on local geology, the better your outline of frontal advance (horizontal water displacement) of the injected waste can be. Of the various methods available for determining the underground landscape, you might select (1) analysis of core samples taken while drilling a test well (2) a combination of downhole logging surveys such as sonic and resistivity measurements (3) spinner profiles of pay zones made while conducting injectivity tests (a hydraulic anemometer reads water velocity in bore hole at each elevation, hence gives detailed porosity data). Or—an excellent solution if it's available—study logs of any wells your neighbors have built.

Another geological consideration is pressurization—the height to which fluid will rise (above original static pressure) because of injection at the disposal well. You can measure fluid rise at an observation well some distance away from the injection well, as chart, lower left, shows. While the reservoir pressure has risen at the observation hole, it has not become a limiting factor. Fluid rise is most significant in the early years of operation; later on it slows down.

Naturally, reservoir pressure rise will increase pressure at the injection well, and you must plan for this increase in designing your wellhead, pumping equipment and its drive. In the economic evaluation of deep-well waste disposal, pumping is the operating cost to consider, along with first cost of the necessary equipment.

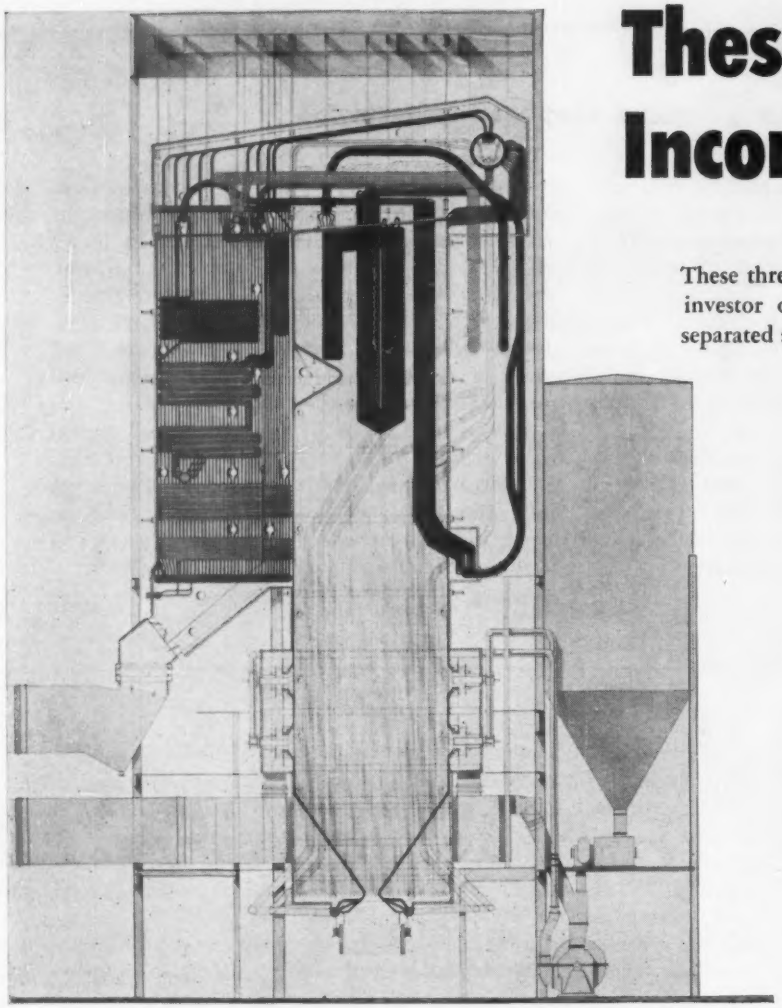
A highly concentrated waste is the second requisite. About 100 gpm appears to be the upper capacity limit for economic consideration. Naturally, the smaller the volume, the greater the chance for successful disposal. High concentration means that waste to be disposed of in a deep well must be carefully handled so that it does not become needlessly diluted. As a matter of fact, pretreatment to concentrate it is frequently needed.

Solids content must be carefully controlled. Since the success of the operation depends upon the ability of a porous rock formation to absorb and distribute the waste material throughout its volume, solids which would soon plug the reservoir must be excluded. Unless the waste is pure liquid to begin with (that is, containing no undissolved solids), filtration will probably be necessary. While there is an economic upper limit to this filtration process, well life and degree of filtration are related. Practical devices are available to remove all particles greater than 15 microns.

As we have said, the first step for any industry contemplating deep-well waste disposal is a careful study of area geology. Logs of all wells built in the area should be studied. If they seem favorable, the next step is sinking a test well. Here, the industry must assume the same risk that the oil wildcatter does when he drills his dry well. Risky as it may appear, there is no other sure method of determining the feasibility of deep-well waste disposal in a particular locality. In unproved formations the test well is the only way to determine true potential. Major risk money involved: drilling cost and possible plugging cost if the potential is not sufficient. But drilling is tax-deductible; only the casing need be capitalized.

One test hole may be enough in some cases, but where special problems exist in reservoir definition or where you have a really big operation in mind, you may need two or more test wells. Only this careful testing procedure will provide the data necessary to make an intelligent decision on deep-well disposal.

These RILEY Incorporate The

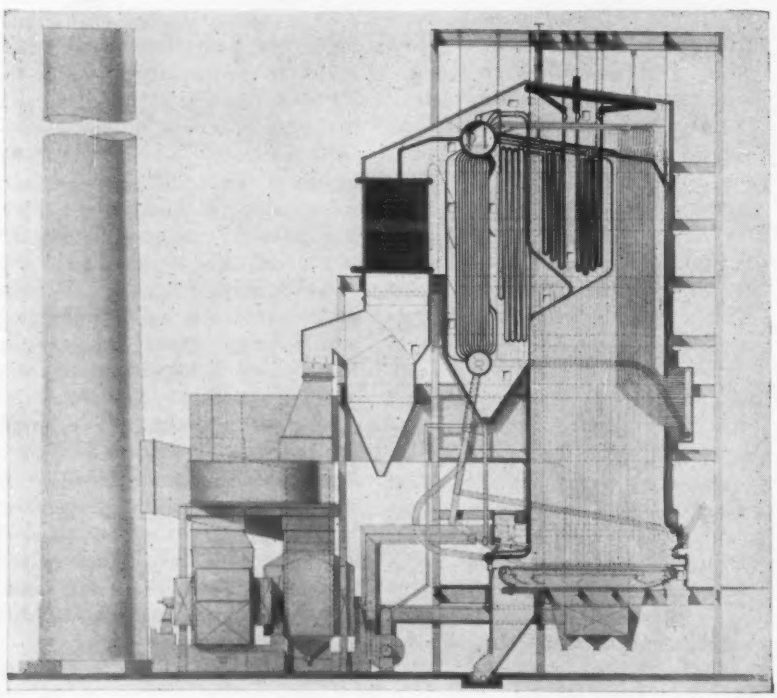


These three Riley boilers are being built for three investor owned electric utilities in three widely separated sections of the country. Featured in these designs are some of the most recent Riley engineering developments, such as the Riley *Turbo Furnace,* new superheater and reheater arrangements, new high capacity steam washer, use of radiant superheater platens, multiple downcomers for uniform distribution of feedwater, opposed wall firing, new '60 type Riley Flare Type Burners and Pulverizers, and the world's largest spreader stoker.

Left —

For A Central Station — Southeast

This dry bottom balanced draft pulverized coal fired unit is a 1,700,000 lbs/hr unit, 2525 psi at superheater outlet, 1005F superheat and 1005F reheat. The unit is fired by five No. 550E Riley Pulverizers and twenty Riley Flare Type Burners with two rows of five burners in the front and rear walls. This boiler will be completely automated.



Opposite Page —

For A Central Station — Southwest

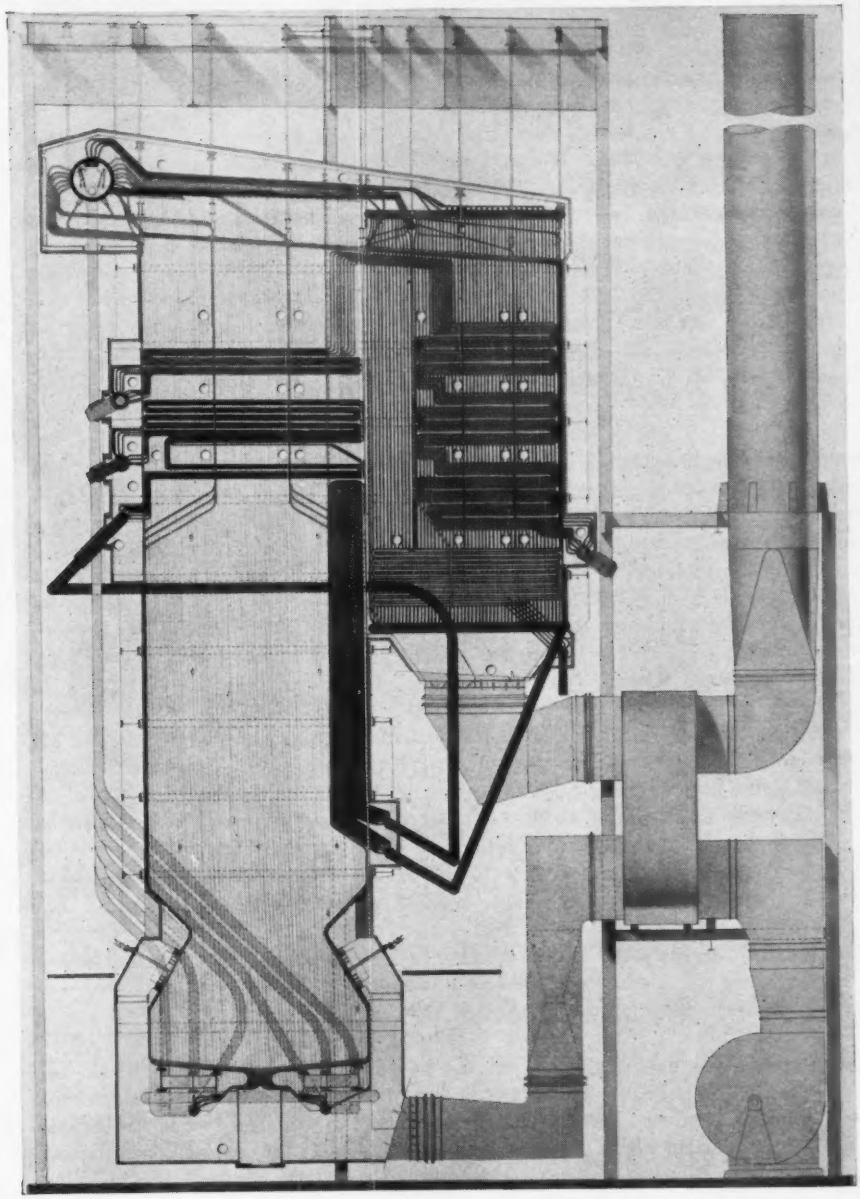
This is a gas fired Turbo Furnace Unit having a normal capacity of 2,486,000 lbs/hr, 2425 psi, and a peak capacity of 2,668,000 lbs/hr at 2590 psi superheater outlet pressure, 1005F superheat and 1005F reheat. It is designed for pressurized operation without induced draft fans, and for future pulverized coal firing with merely the addition of water tube platens.

Left —

For A Central Station — Northwest

This unit will be by far the largest spreader stoker fired lignite burning boiler. The Riley Traveling Grate Spreader Stoker is 38'-0" wide by 27'-0" shaft centers. The boiler is designed for a continuous capacity of 650,000 lbs/hr, 1300 psi, superheater outlet 955F, and a peak capacity of 685,000 lbs/hr. It will burn 6680 Btu. North Dakota lignite. Among the reasons for selection of spreader stoker firing of lignite were the large savings in power and maintenance over pulverized coal firing.

Central Station Boiler Designs Latest Riley Engineering Features



Some Electric Utility Riley Customers

Arizona Public Service Co.
Carolina Power & Light Co.*
Central Power & Light Co., Texas
Kansas Gas & Electric Co.
Holyoke Water Power Co.*
Minnesota Power & Light Co.*
Eastern Iowa Light & Power Co.
Philadelphia Electric Co.*
Louisiana Power & Light Co.*
Texas Electric Service Co.*
Public Service Company of Indiana, Inc.*
Arkansas Power & Light Co.
Utah Power & Light Co.*
Columbus & Southern Ohio Electric Co.*
Central Illinois Light Co.*
Houston Lighting & Power Co.*
South Carolina Electric & Gas Co.*
Union Electric Co., Missouri*
Southern Nevada Power Co.
Commonwealth Edison Co.
Florida Power Corporation*
Dallas Power & Light Co.*
Monongahela Power Co., — The Potomac Edison Co.*
Delaware Power & Light Co.
Southwestern Gas & Electric Co.
Northern States Power Co.
Central Louisiana Electric Co.*
Gulf Power Co.*
Pennsylvania Electric Co.
Iowa Electric Light & Power Co.*
Montana-Dakota Utilities Co.*
Mississippi Power Co.*
Ohio Edison Co.*
Iowa Public Service Co.*
Interstate Power Co.*
Pacific Gas & Electric Co.
Southern Indiana Gas & Electric Co.
Upper Peninsula Power Co.
New Orleans Public Service Inc.*
Northern Virginia Power Co.
Iowa-Illinois Gas & Electric Co.*
West Penn Power Co.
Upper Michigan Power & Light Co.*
Superior Water, Light & Power Co.
The Cliffs Power & Light Co.
Otter Tail Power Co.*
North Dakota Power & Light Co.
The Hartford Electric Light Co.
Worcester County Electric Co.

*Have placed repeat orders.

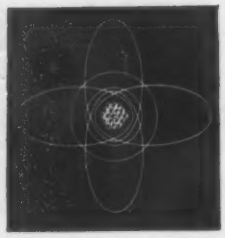
A careful survey of your plant by a qualified consulting engineer could show ways of making substantial savings in power costs.

RILEY

STEAM GENERATING & FUEL BURNING EQUIPMENT

For Complete Details About Riley Boilers Write RILEY STOKER CORPORATION, WORCESTER, MASSACHUSETTS

Sales Offices: Boston, Charlotte, Chicago, Cincinnati, Cleveland, Denver, Dertoit, Honolulu, Jacksonville, Kansas City, Los Angeles, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Salt Lake City, San Francisco, St. Louis, St. Paul, Seattle, Syracuse.



Nuclear notes

By B G A SKROTZKI, Associate Editor

New 325-mwe boiling-water-reactor plant is planned by Pacific Gas & Electric Company for installation at Bodega Bay, 50 miles north of San Francisco, Calif. Provided licenses and permits are forthcoming, construction starts in August 1962 and operation at the end of 1965. Plant is estimated at $181 per kwe. PG&E will buy fuel from General Electric Company, paying $8.4 million for fabrication, and pay AEC's annual rental charge of 4.75% on $60 per lb. Fuel will be 75 tons UO_2 enriched to 2½%; in-core life estimate: 3½ yr. Fuel costs are estimated at 5.62 mills per kwhr compared to 5.77 mills for conventional oil-burning plant at same site. Second core is expected to drop to 5.32 mills. Reactor will use forced-circulation direct-cycle boiling-water design with internal steam separation. Single-shaft turbine-generator will get 1000-psig 544-F steam. Though using pressure-suppression containment, reactor will be enclosed in a 120-ft-dia concrete and steel structure based about 100 ft below grade. (*McGraw-Hill World News*)

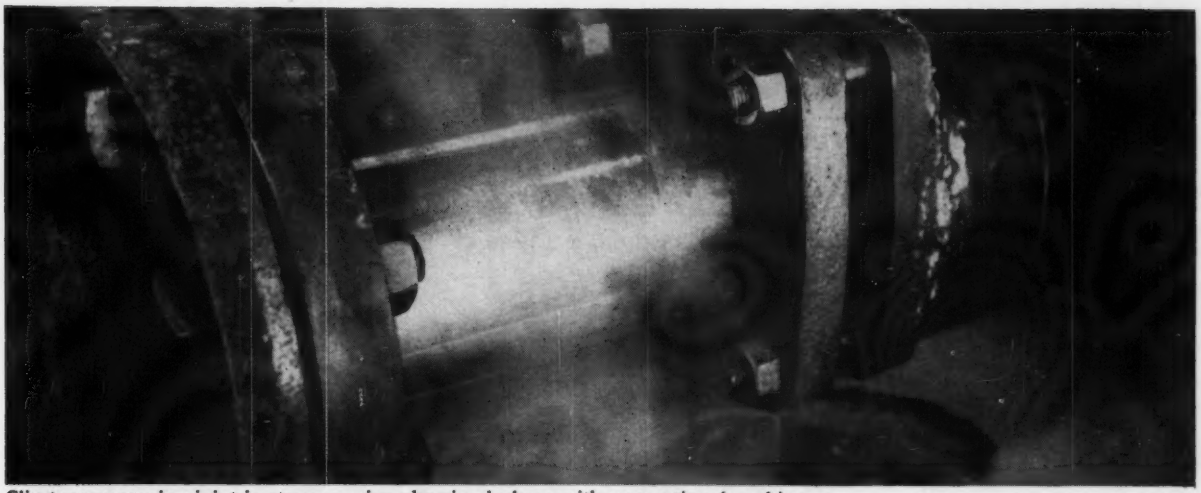
West German reactor program to be completed by 1962 for small and medium capacities includes 5- and 20-mwe high-temperature units by BBC/Krupp; 35-mwe advanced gas-cooled reactor with slightly enriched uranium by Babcock & Wilcox; 25-to-35-mwe organic-moderated reactor by Interatom; 25-mwe boiling-water reactor with nuclear superheating by AEG and a transportable plant of 2 to 10 mwe with pressurized water by MAN. The German government hopes the plants will be largely financed and developed by private industry with some government subsidy. If this should not develop, West Germany may pay for the entire program—about $7.5 million per project. (*McGraw-Hill World News*)

TRANSIT satellite now in orbit carries a nuclear generator fueled with plutonium 238; it's the first moon to carry a nuclear plant of the SNAP type. Roughly spherical, the 5½-in.-dia generator uses thermocouples to convert heat of decay directly into electric energy. Pu-238 has a half life of about 90 years and a low gamma-radiation level as well as high thermal-power density. Without fuel the generator costs $4800; while no capacity figures have been released, the SNAP program covers units developing 5 to 500 watts.

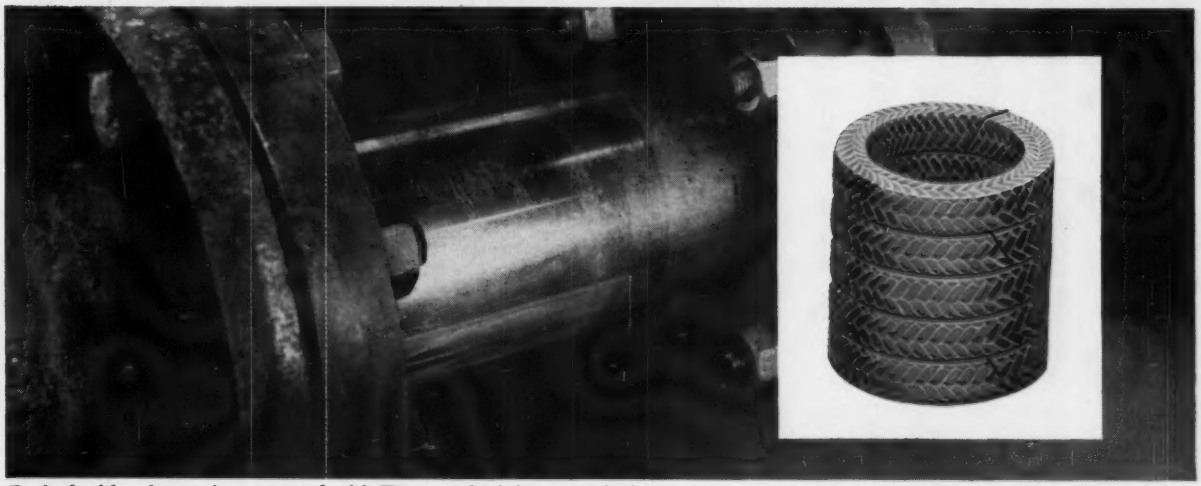
Yankee Reactor at Rowe, Mass. has been licensed to raise its operating level from 392 to 485 mwt starting June 23. This corresponds to an increase from 110 to about 136 mwe. License revises the expiration date to Nov 4, 1997.

SL-1 explosion cause has not been fixed, but the Board of Investigation of the AEC reports: We cannot assign cause . . . to any known or unknown act . . . preceding the incident. Before the incident . . . condition of reactor core and control system had deteriorated to such an extent that a prudent operator would not have allowed operation of reactor to continue. . . . It seems extremely improbable that the required motion of the central control rod could have occurred accidentally unless the rod had been stuck in the shroud and became free while one or more operators were exerting a large upward force on it. While there is no direct evidence that this occurred, this appears to be less implausible than any other suggested hypothesis.

Sierra Pacific Power Company of northern Nevada plans to build a 75-mwe nuclear-power plant near Reno between 1965 and 1970; details have not been worked out as yet. The system now is a distributing utility, buying power from Pacific Gas & Electric Company over three transmission lines. (*McGraw-Hill World News*)



Slip-type expansion joint in steam service, showing leakage with conventional packing.



Packed with asbestos impregnated with TEFLON, the joint never leaks.

The difference?... Packings of asbestos and TEFLON® TFE

Consider the difference that a switch to packing of asbestos impregnated with a Du Pont TEFLON TFE-fluorocarbon resin can make in your maintenance problems and costs! In the case shown above, an expansion joint in high-pressure steam service leaked periodically (top photo) . . . required retightening five times a year . . . packing replacement on the average of once a year. When conventional packing was replaced by asbestos impregnated with TEFLON, packing maintenance problems ended. No steam leaks, no condensate, no periodic adjustment and replacement. Savings in labor and materials were substantial, and wasteful steam loss was eliminated.

Under more severe service conditions, there are additional decisive reasons for choosing packings made with TEFLON. TEFLON TFE resins are inert to virtually all chemicals and solvents, over a temperature range from –450°F. to 500°F. Their low-friction characteristics reduce wear on cylinders and shafts.

In addition to reduced costs of packing maintenance and replacement, the use of TEFLON permits standardization, cuts down inventories of many different types of packing. Consult your supplier about the many constructions available in packings made with TEFLON and write for new booklets: "Packings for Valves and Pumps", and "Designing with TEFLON". Address: E. I. du Pont de Nemours & Co. (Inc.), Dept. P-8, Room 2507T, Nemours Building, Wilmington 98, Delaware. *In Canada:* Du Pont of Canada Limited, P. O. Box 660, Montreal, Quebec.

DU PONT REG. U. S. PAT. OFF.

TEFLON® FLUOROCARBON RESINS

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

TEFLON is Du Pont's registered trademark for its family of fluorocarbon resins, including TFE (tetrafluoroethylene) resins and FEP (fluorinated ethylene propylene) resins.

Power's data sheet

No. 348

Alloy-steel pipe to ASTM Spec A-335 Grade P-1 (½% moly) and ASTM Spec A-335 Grade P-2 (½% Cr–½% moly)

Pipe size, in.	Nom OD, in.	Wall thick, in.	Temperature, F: To 750	800	850	875	900	950	975
			Maximum allowable stress, psi: 13,750	13,450	13,150	12,825	12,500	10,000	8125
Schedule 10									
14	14	.250	436	426	417	406	396	318	259
16	16	.250	381	372	364	355	346	278	226
18	18	.250	338	330	323	315	307	246	201
20	20	.250	304	297	291	283	276	221	180
24	24	.250	253	247	242	236	230	184	150
Schedule 20									
8	8.625	.250	713	697	682	665	648	521	426
10	10.75	.250	570	557	545	531	518	416	339
12	12.75	.250	479	468	458	447	435	350	285
14	14	.312	545	533	521	508	495	398	324
16	16	.312	476	465	455	444	432	347	283
18	18	.312	422	413	404	394	384	308	251
20	20	.375	457	447	437	426	415	333	272
24	24	.375	380	372	363	354	345	277	226
Schedule 30									
8	8.625	.277	789	772	755	736	717	577	472
10	10.75	.307	702	687	672	655	638	513	419
12	12.75	.330	635	621	607	592	577	464	379
14	14	.375	657	642	628	612	597	480	392
16	16	.375	573	561	548	535	521	419	342
18	18	.438	595	582	569	555	541	435	355
20	20	.500	613	600	586	572	557	448	365
24	24	.562	573	561	548	535	521	419	342
Schedule 40									
½	.840	.109	1011	989	967	943	919	741	606
¾	1.05	.113	914	894	874	853	831	669	547
1	1.315	.133	1100	1076	1052	1026	1000	806	660
1¼	1.66	.14	988	967	945	922	899	724	593
1½	1.90	.145	921	901	881	859	838	675	552
2	2.375	.154	830	812	794	774	754	607	496
2½	2.875	.203	1116	1091	1067	1040	1014	818	670
3	3.50	.216	1003	981	959	935	912	735	601
4	4.50	.237	1313	1285	1256	1225	1194	964	791
5	5.563	.258	1154	1129	1104	1077	1050	847	694
6	6.625	.28	1048	1025	1002	977	953	768	629
8	8.625	.322	923	903	883	861	839	676	553
10	10.75	.365	836	818	799	780	760	612	500
12	12.75	.406	783	766	749	730	712	573	468
14	14	.438	769	752	736	719	699	563	460
16	16	.50	770	753	736	718	700	563	460
18	18	.562	768	752	735	717	699	562	459
20	20	.593	730	714	698	681	664	534	436
24	24	.687	704	689	673	657	640	515	420
Schedule 60									
8	8.625	.406	1170	1145	1119	1092	1064	1858	704
10	10.75	.50	1158	1133	1108	1080	1053	849	696
12	12.75	.562	1095	1071	1047	1021	995	803	658
14	14	.593	1053	1030	1007	982	957	771	632
16	16	.656	1016	994	971	947	923	744	609
18	18	.750	1032	1010	987	963	938	756	619
20	20	.812	1006	984	962	939	915	737	603
24	24	.968	1000	978	956	933	909	733	600
Schedule 80									
½	.84	.147	2231	2182	2134	2081	2028	1649	1363
¾	1.05	.154	1937	1894	1852	1806	1761	1429	1178
1	1.315	.179	2036	1992	1948	1899	1851	1503	1240
1¼	1.66	.191	1777	1738	1700	1658	1616	1309	1078
1½	1.90	.20	1669	1633	1597	1557	1518	1229	1011
2	2.375	.218	1523	1490	1456	1420	1384	1120	920
2½	2.875	.276	1780	1741	1702	1660	1618	1312	1080
3	3.50	.30	1630	1594	1558	1520	1481	1199	986
4	4.50	.337	1903	1861	1820	1775	1730	1403	1156
5	5.563	.375	1701	1664	1627	1587	1547	1253	1031
6	6.625	.432	1644	1608	1572	1533	1494	1210	995
8	8.625	.50	1455	1424	1392	1358	1323	1070	879
10	10.75	.593	1384	1354	1323	1291	1258	1017	834
12	12.75	.687	1349	1320	1290	1259	1227	991	813
14	14	.75	1337	1310	1280	1249	1217	983	807
16	16	.843	1319	1290	1261	1230	1199	969	795
18	18	.937	1302	1273	1245	1214	1183	956	784
20	20	1.031	1287	1257	1231	1200	1170	945	775
24	24	1.218	1268	1240	1212	1182	1152	931	763

Pipe size, in.	Nom OD, in.	Wall thick, in.	Temperature, F: To 750	800	850	875	900	950	975
			Maximum allowable stress, psi: 13,750	13,450	13,150	12,825	12,500	10,000	8125
Schedule 100									
8	8.625	.593	1742	1704	1666	1625	1583	1283	1056
10	10.75	.718	1688	1651	1614	1575	1535	1243	1023
12	12.75	.843	1671	1635	1598	1559	1517	1230	1012
14	14	.937	1692	1655	1618	1578	1538	1246	1025
16	16	1.031	1624	1588	1553	1514	1476	1195	983
18	18	1.156	1619	1584	1548	1510	1472	1191	980
20	20	1.281	1614	1578	1543	1505	1467	1188	976
24	24	1.531	1607	1572	1537	1499	1461	1183	972
XX									
½	.84	.294	7690	7522	7355	7173	6991	5924	5116
¾	1.05	.308	6363	6224	6085	5935	5784	4852	4143
1	1.315	.358	6103	5970	5837	5692	5548	4645	3958
1¼	1.66	.382	5119	5007	4896	4775	4654	3867	3268
1½	1.90	.400	4688	4586	4883	4373	4262	3530	2973
2	2.375	.436	4107	4017	3928	3831	3734	3079	2581
2½	2.875	.552	4523	4424	4326	4219	4112	3401	2861
3	3.50	.600	4039	3951	3863	3768	3672	3027	2536
4	4.50	.674	4028	3940	3852	3757	3661	3018	2828
5	5.563	.750	3580	3502	3424	3339	3254	2673	2232
6	6.625	.864	3453	3378	3302	3221	3139	2576	2148
8	8.625	.875	2629	2571	2514	2452	2390	1949	1615
Schedule 120									
4	4.50	.438	2511	2457	2402	2342	2283	1860	1540
5	5.563	.50	2310	2260	2209	2155	2100	1709	1413
6	6.625	.562	2171	2123	2076	2025	1973	1604	1325
8	8.625	.718	2129	2083	2037	1990	1986	1573	1299
10	10.75	.843	2001	1957	1913	1266	1819	1476	1218
12	12.75	1.00	1997	1953	1910	1862	1815	1474	1215
14	14	1.093	1988	1945	1902	1855	1808	1467	1210
16	16	1.218	1937	1895	1853	1807	1761	1429	1178
18	18	1.375	1942	1899	1857	1811	1765	1432	1181
20	20	1.50	1905	1864	1822	1777	1732	1405	1158
24	24	1.812	1919	1877	1835	1790	1744	1415	1166
Schedule 140									
8	8.625	.812	2427	2374	2321	2264	2206	1797	1486
10	10.75	1.00	2394	2342	2290	2233	2177	1772	1466
12	12.75	1.125	2262	2213	2163	2110	2056	1673	1382
14	14	1.25	2292	2242	2192	2138	2084	1695	1401
16	16	1.437	2307	2257	2207	2152	2098	1707	1411
18	18	1.562	2223	2175	2126	2074	2021	1644	1358
20	20	1.75	2242	2193	2144	2091	2038	1658	1370
24	24	2.062	2199	2151	2103	2051	1999	1625	1343
Schedule 160									
½	.84	.187	3618	3539	3461	3375	3289	2703	2257
¾	1.05	.218	3682	3602	3522	3435	3348	2752	2299
1	1.315	.25	3550	3473	3395	3311	3227	2650	2212
1¼	1.66	.25	2756	2695	2635	2570	2505	2045	1696
1½	1.9	.281	2838	2774	2712	2645	2578	2106	1748
2	2.375	.343	2967	2902	2838	2768	2697	2206	1832
2½	2.875	.375	2713	2654	2595	2531	2466	2013	1669
3	3.50	.438	2694	2636	2577	2513	2450	1997	1657
4	4.50	.531	3098	3030	2962	2889	2816	2305	1917
5	5.563	.625	2934	2870	2806	2737	2668	2181	1811
6	6.625	.718	2825	2764	2702	2635	2568	2098	1741
8	8.625	.906	2729	2669	2610	2545	2481	2025	1679
10	10.75	1.125	2716	2657	2598	2534	2469	2015	1671
12	12.75	1.312	2668	2610	2552	2489	2426	1979	1640
14	14	1.406	2599	2542	2485	2424	2363	1926	1596
16	16	1.593	2577	2521	2465	2404	2343	1910	1582
18	18	1.781	2557	2501	2446	2385	2325	1895	1569
20	20	1.968	2544	2489	2833	2373	2313	1885	1561
24	24	2.343	2522	2467	2412	2353	2293	1869	1547

Maximum allowable working pressure-3

Figures in table are maximum pressures, psi, for given temperatures and stresses. Don't exceed 875 F for P-1 and 975 F for P-2. See June *Data Sheet 346* for basic formula used to calculate the table.

GEORGE C HALZELL, *Boston, Mass.*

© POWER

"Made OF Stainless Steel ...Made BY Jenkins"

And the "BY" is the most important word in that Spec!

Let's talk sense about stainless steel valves.

The material, the metal itself, is pretty much a cut-and-dried matter of *specifications* — selecting the right metal for a particular application. After all, the same alloys are available to *all* valve manufacturers!

But —

Just as is the case with iron or bronze valves, the basic and essential difference is in the *way* valves are made. *Perfection of castings . . . precision machining . . . sound design . . . painstaking inspection and testing* —

These are the really meaningful, the sense-making factors which impel more and more buyers to specify "BY Jenkins," along with the specification for a particular alloy.

At Jenkins every operation, every process, every test, every worker — all combine to fulfill the traditional (almost 100 years old!) standard of Jenkins quality — the very highest, the *standard* of quality for valves.

SEND FOR CATALOG 59-SS of Jenkins Stainless Steel Valves in types and alloys to fill 99 out of 100 application requirements. All made the Jenkins way to give you the longest, most dependable valve performance money can buy. Jenkins Bros., 100 Park Ave., New York 17.

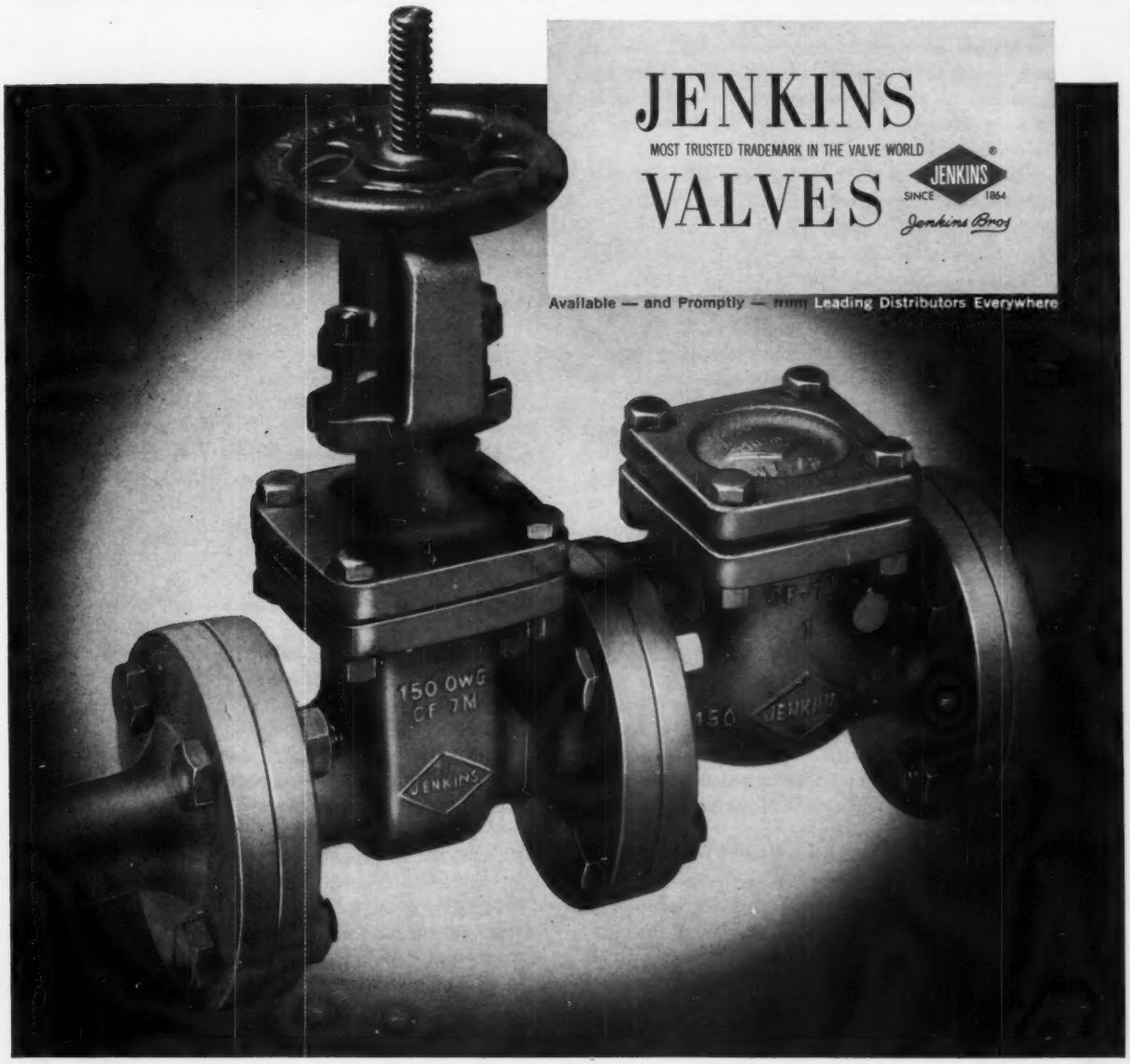
JENKINS

MOST TRUSTED TRADEMARK IN THE VALVE WORLD

VALVES

JENKINS SINCE 1864 Jenkins Bros

Available — and Promptly — from Leading Distributors Everywhere



For more facts circle 255 on Reader Service card, p 107

Technical briefs . . . A world-wide look at

To find out how to get more information on any of these papers, see box on p 106

High-temperature insulation, new drives and excitation systems explored

Electric motors at higher temperatures for industrial usage, *F C Rushing, Westinghouse Electric Corporation*

Motor life is determined primarily by the insulation; insulation life is limited by several factors: mechanical strength, voltage endurance, moisture and chemical resistance and thermal endurance. Temperature rise has a measurable effect on insulation life. As a general rule, insulation life is halved by each increase of 10 C.

The AIEE has set standards to classify insulations at hot-spot temperatures:

105 C	Class A
130 C	Class B
155 C	Class F
180 C	Class H

NEMA's standards are based on these; they assume a 40-C ambient to which motor-temperature rise is added.

Insulations are then classified by material and usual application. Materials include fiber and paper coverings, enamel insulation, fabric plus enamel and ground insulation.

European practice is detailed and compared to ours. Their idea is to sacrifice motor life for economy through size reduction and use of less material. For these reasons, a standard European motor's life would be about 1/3 the life of a standard American motor on the same service. *ASME 61-MD-9*

Accelerated aging tests to compare silicone-rubber insulation with Class A and B insulation systems, *P Nelson, Southern Calif. Edison Co and R J Potts, Allis-Chalmers Manufacturing Company*

Three test coils, all insulated for 2300 v, were subjected to accelerated aging with periodic breakdown testing. Starting test temperatures were set to agree with Class A ratings. Then Class B temperatures were applied, finally Class H (silicone) temperatures. Breakdown tests after temperature exposure were followed by mechanical stressing and moisture exposure to further test the insulation.

Conclusion: mechanical stress, moisture exposure and voltage duress will not harm a well-designed insulation system unless the chemical and deteriorating effects of aging have appreciably reduced the coil's physical strength. Aging temperatures plotted against cycles of accelerated aging show areas of failure for all three insulation classes. *AIEE DP 61-599*

Static, electronic and rotating excitation systems for turbine-generators, *L M Domeratzky, A S Rubenstein, M Temoshok, General Electric Company*

Operating history and application of all excitation systems are covered, but the static excitation system gets greatest attention in view of its newness. Major parts of the system: (1) static magnetic power components (power-potential transformers, linear reactors and single-phase saturable-current transformers) (2) rectifier (consisting of two individual 3-phase full-wave bridge assemblies of water-cooled silicon diodes) (3) an automatic ac voltage regulator to improve accuracy of ac-generation voltage.

Advantages of a static excitation system include increased reliability, lower maintenance, arrangement flexibility, reduced overall length of the turbine-generator and easier removal of the generator rotor. *AIEE DP 61-569*

Magnaflow and rectiflow adjustable-speed drives for pumping and other applications, *R P Bleikamp, Westinghouse Electric Corporation*

Choice among adjustable-speed-drive types is wide —electrical, mechanical, hydraulic. And within each type, many variations meet specific needs. In the electrical area, two of the less well-known drives are discussed in detail: (1) electromagnetic-coupling drive and (2) a wound-rotor motor mechanically coupled to a direct-current motor.

Electromagnetic-coupling drive consists of an output rotor mounting a coil which excites the unit. Outer drum is the input member. Magnetic flux created by the direct current in the coil produces eddy currents in the outside drum when speed differences exist. Torque is then transmitted from input to output member.

Second arrangement has constant-hp output capability over its speed range, since the wound-rotor motor can have constant torque and the dc motor converts essentially all slip power to shaft power.

Economic analysis compares these drives for several pumping applications. *AIEE DP 61-556*

progress in energy-systems engineering

15 papers for you on:
WATER TECHNOLOGY
AUTOMATIC CONTROL
LUBRICATION

Water technology

Four years of operating experience with a 3200-gpm demineralizer, *R I Smith and H D Reppin, Public Service Electric and Gas Company*
Linden Generating Station of Public Service Electric and Gas Company has two 225-mw units. In addition, unit No. 1 supplies up to 1,150,000 lb per hr of steam at 750 and 150 psig to an adjacent oil refinery under normal operating conditions. This process steam is lost to the system—so makeup requirements are high.

The 3200-gpm treatment plant normally takes well water (city water is also available in an emergency) through a primary plant made up of prechlorination, coagulation and filtration with pH adjustment. Then a demineralizer plant—cation exchange, vacuum degasification, weak- and strong-base anion exchange and finally mixed-bed polishing—completes the treatment picture. Guaranteed effluent quality: 0.02-ppm total dissolved solids, 0.5-mmhos conductivity and 0.01-ppm dissolved silica.

Four years of satisfactory operation have resulted from this design. But minor difficulties included increased final-rinse requirements of weak-base anion resin. Solution: installing a new resin in one unit and using old resin to deepen other weak-base anion beds. Corrosion of buried acid piping was another early problem. Replacement piping was laid in a concrete trench and stainless-steel mixing tees were installed. *APC*

The economics of salt-water conversion for the power industry, *G E Sonderman, Singmaster & Breyer*
Progress in sea-water conversion is traced from 1955 to date; water costs have fallen consistently with improved cycles. In 1955, PG&E's 144,000 gpd plant produced fresh water for $2.50 per 1000 gal; current plants sponsored by the U.S. Dept of the Interior are estimated at $1.00; developers of sea-water-conversion equipment now talk in terms of 50¢ per 1000 gal. All plants, operating and under development, are detailed.

Major areas for future improvement in sea-water technology: (1) increasing initial temperature to over 200 F through improved scale-prevention techniques (2) improving heat-transfer factors through use of dynamic surfaces (3) combinations of processes, such as teaming vapor compression for the denser vapors above atmospheric pressure with distillation (4) developing low-cost heat sources—spent nuclear fuels, gas-turbine exhausts. *APC*

Automatic control

A supervisory control and telemetering installation in an industrial plant, *H O Bourque, Ethyl Corporation*
In the Baton Rouge plant of the Ethyl Corporation, supervisory control and telemetering apparatus have been applied in three areas: incoming electric power and distribution system, rectifier substations and the plant-services system—water treatment and supply, drive motors and turbines. In each case, equipment design and operating procedures are detailed.

Physical spread of the plant-services system dictated centralized control with one major remote station located at the river-water-clarification plant. This includes, in addition, some of the process-water system and two cooling towers in the immediate vicinity. *AIEE DP 61-493*

Control philosophy for a boiling-water reactor with an integral nuclear superheater, *David Crimmins, J T Stone, Allis-Chalmers Mfg Co*
Pathfinder Atomic Power Plant consists of a 66-mwe 600-psig boiling-water reactor designed to produce superheated steam at 850 F. Primary control requirement for this type of power source: match up energy release in the reactor with energy delivered at the turbine. Nuclear superheater complicates control problem considerably.

Pressure increase in the reactor reduces boiler-core steam volume by (1) shifting point of boiling higher up the core (2) increasing steam density (3) causing some condensation of steam in the core. Boiler-core reactivity and hence reactor power tend to increase with rising pressure. This is a positive feedback loop in the transfer system, so controls must keep reactor pressure nearly constant.

Effects of superheater-pressure drop, parameters affecting time lag, improvement in system response using superheater-temperature signal and root-locus analysis of system response are covered in detail. *AIEE DP 61-566*

Control design in automatic gas transmission, *D C Washburn, Westinghouse Electric Corp*
Control of gas transmission has grown through several steps from purely manual to computer control. Each step has brought up more and more difficult problems of equipment coordination. Improvement of system operation is the goal, and there are many ways of attaining this. Control requirements include subsystem protection, safe failure, reliability, optimization of transmission costs.

continued

NEW GENERAL ELECTRIC

Transistorized Analog

FREQUENCY TELEMETERING OFFERS GREATER SPEED OF RESPONSE, INCREASED ACCURACY

Now available! General Electric's all-new Analog Frequency Telemetering System provides greatest possible *FLEXIBILITY* to meet utility load dispatching and industrial data transmission applications.

Universal design can be easily modified for varying applications resulting in system simplicity and flexibility. Manufacturing standardization assures quick delivery.

Optional plug-in audio-tone equipment permits transmission of data over voice or microwave channels where tone frequencies are required. Optional tone transmitter and receiver offer forty different tone frequencies available with conventional shift-type operation.

Completely transistorized system has *no* vacuum tubes. Telemeter transmitter, tone transmitter and receiver use only transistors in their circuitry. Telemeter receiver utilizes only diodes.

Compact System rack mounts—conserves valuable panel space.

Plug-in application adapters determine input range and output signals for both the transmitter and receiver. Plug-in filters and transformers select tone frequencies.

Combined accuracy of transmitter and receiver is ±0.5 percent of full span over these variations: ± 15°C temperature, ± 5 percent voltage change, ± 3 cycles frequency. A combined accuracy of ± 1 percent of full span is assured even when the transmitter is subjected to −20 to 55°C or ± 10 percent voltage change.

System stability—±0.5 percent of full span in six months plus ±0.1 percent of full span per each subsequent six months.

Quick response—system speed of response is rated 1 second for 99 percent of scale range—practically instantaneous. Such response is invaluable in applications involving load-frequency control wherein high-speed response is essential. In addition, there is no overshoot.

For utility telemetering in transmitting rapid fluctuation of electrical quantities such as watts, vars, volts and amperes . . . for fast positive transmission of industrial process data including quantities of pressure, temperature, liquid level, flow and many others . . . check into the cost saving advantages of G.E.'s new Analog Frequency System today. Your nearest G-E sales representative will be glad to provide you with additional information on this all-new low cost system. Be sure to ask for bulletin GEA-7163, or write direct to General Electric Company, Section 599-07, Schenectady 5, N. Y.

INSTRUMENT DEPARTMENT

GENERAL ELECTRIC

Technical briefs

To develop such a control system, you need a thorough understanding of the processes and phenomena to be controlled. This usually involves constructing a mathematical model. Model will also mean less debugging of the installed control system. *AIEE DP 61-495*

Lubrication

Oil-fog lubrication—past, present and future, *D G Faust, C A Norgren Company*

Oil-fog-lubrication technology is brought up to date from its inception in 1926, and parameters of this aerosol-lube principle are covered.

Two distinct application categories exist; they are fundamental and cannot be used interchangeably. (1) A low concentration of fog in air is used for lubricating air-operated devices such as air tools. (2) A high concentration is specifically applied to bearings, gears and chains. Equipment design fits only one of these categories at one time, so equipment must be chosen specifically for the job to be done.

Lube needs can be translated into "bearing inches." In its simplest form, this means the shaft diameter of a single-row rolling-contact bearing. In a plain bearing, it is 25% of the projected area. A good rule of thumb to follow in determining lube needs of bearings: allow 0.02 fl oz per hr per bearing inch.

Components of a good oil-fog lubrication system: (1) air-line filter (2) pressure regulator (3) aerosol lubricator and (4) reclassifier. In addition, optional auxiliaries are discussed. *ASLE 61 AM 2A-3*

Metal bellows seals, *R W Blair, D L Johnson, J P Morley, Chicago Rawhide Mfg Co*

Both temperature extremes lead to the use of bellows seals in rotating machinery— –65 F to absolute zero in cryogenic service and 500 F and above in hot-turbine gas seals.

Two basic bellows - fabrication methods, hydraulic forming and welding, are covered in detail. Other factors include spring rates, pressure limits, fatigue properties, vibration and materials. *ASLE 61 AM 1B-3*

For more facts circle 256 on Reader Service card, p 107

Begins on page 102

The lubrication of ball bearings with solid films, *M J Devine, E R Lamson, J H Bowen, Naval Air Material Center, Philadelphia*

Ball-bearing tests used a solid lubricant made up of 71% MoS_2, 7% graphite, 22% sodium silicate (all by weight). Since retainer wear normally occurs at three points in each area of ball contact, reservoir pockets were cut at these points to hold the solid lube. After assembly, a standard test spindle determined performance life.

Test results: an 18-4-1 tool-steel ball bearing with modified cast-iron retainers lasted several-hundred hours at 750 F and 3500 rpm. Comparative tests revealed that rectangular lube pockets increase running time over cylindrical pockets.

Studies of retainer material, internal clearance and roughness are currently under way. *ASME 61-LUBS-11*

Low-temperature pumpability of crankcase oils, *R G Moyer, Pure Oil Company*

To determine low-temperature-pumping characteristics of common engine oils, a test rig was developed. The rig used an automotive lube-oil pump which could operate at controlled low temperatures. In addition, effect of additives was an unknown to be determined.

Tabulated data covers results at temperatures as low as –57 F for SAE 5W-20 and 10W motor oils. Results, in terms of run time and oil volume pumped, give flow rates in cc per sec. *ASLE 61 AM 1C-1*

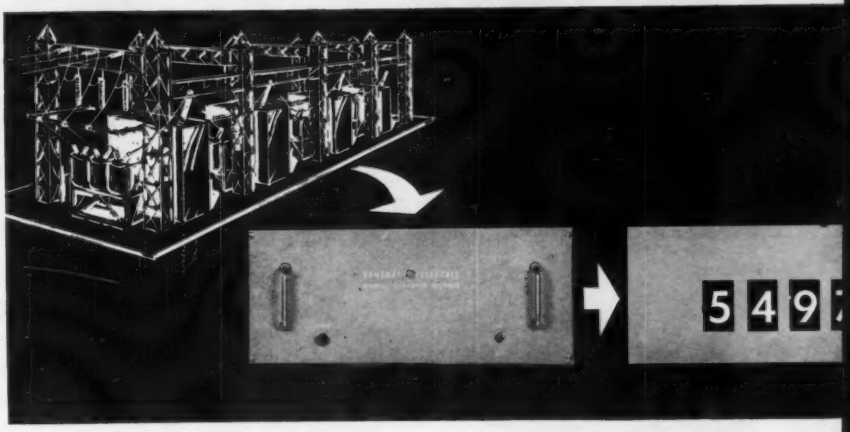
A mechanical high-speed-gearing lubrication problem, *W F Diehl, General Motors Corporation*

Tests showed that high-speed gearing with pitch-line velocities of 15,000 fpm needs special design. In this range, with open gearing, lubricant and air formed a froth which filled the gear housing. Result: in one case torque required merely to turn over the gears was more than rated torque of drive units High torque needs depended on: (1) lubricant viscosity (2) type of shaft bearing (3) method of applying lube (4) point of appli-

NEW GENERAL ELECTRIC

Digital Telemetering

SYSTEM FOR FAST, HIGH ACCURACY DATA TRANSMISSION



For fastest, most accurate utility load or billing information, General Electric's all-new Digital Telemetering System brings kilowatt-hour information into load dispatching office over one channel, with *100 PERCENT ACCURACY*. Offers outstanding system values . . .

Flexibility: Digital telemetering signal can be time-multiplexed with an analog telemetering signal at a preset time interval, thus providing minimum channel expense and lower operating costs. Or the digital telemetering system can be used over its own isolated channel to transmit information on command. This system will also operate over any intermediate channel equipment capable of accommodating standard analog "frequency" telemetering signals.

Accuracy: Digital receiver self-checking feature permits only the read-out of correct numbers.The receiver will cancel the readout if there has been an incorrect code or interference of the coded signal during transmission.

Speed: Digital transmission is in the form of long and short pulses at average rate of 10 cps. A six digit number can be telemetered in less than five seconds.

Design: System utilizes time-proved relays and stepping switches that require minimum maintenance. No tubes or transistors are used. Equipment is furnished in 19-inch rack, dust-proof cases with slide-out drawers.

Cost: System price is usually less than the cost of comparable integrating devices which it now obsoletes.

Various read-out devices are available depending on your requirements. These include: electric typewriter, visual digital display units and tape punch equipment if you wish to use the information in a digital computer. Digital transmitters and receivers can be provided for either 4, 6 or 8 digit numbers.

For additional information on the all-new G-E Digital Telemetering System, just call your nearest General Electric sales office, ask for a copy of bulletin GEZ-3312, or write direct to General Electric Company, Section 599-07A, Schenectady 5, N. Y. In Canada, contact Canadian General Electric Company Ltd., 940 Lansdowne Avenue, Toronto 4, Ontario.

INSTRUMENT DEPARTMENT

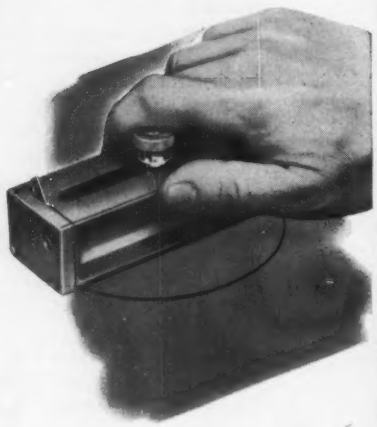
GENERAL ELECTRIC

For more facts circle 257 on Reader Service card, p 107

with the ALLPAX Gasket Cutter

Maintenance men from Maine to Mexico have found that they can save hours of costly "down time" with this handy kit. Accurate gaskets can be cut quickly and easily by following a few simple directions—as easily as drawing circles with a compass.

The Allpax Gasket Cutter uses the "ironing principle" to hold material flat during the sweep of the cut, and prevents buckling and tearing common with make-shift devices. All materials in general use as gaskets may be cut to diameters ranging from ¼" to 36" using the popular No. 3 kit. Other kits available for maximum diameters of 12, 24, 48 and 60 inches. Allpax Gasket Cutters and accessory tools are neatly packaged in the permanent metal tool case shown above. An 18" square cutting board is supplied with each kit.



See your local dealer for additional information on the Allpax gasket cutter and our complete line of gasket materials.

ALLPAX

"The Packing that Packs All"

SEND FOR OUR CATALOG — TODAY!

A complete line of packing, tools, gasket materials
Distributors in principal cities

THE ALLPAX COMPANY, INC.
160 Jefferson Ave., Mamaroneck, N. Y.
CANADIAN DISTRIBUTORS: Albion Asbestos Packings Ltd., Montreal 18, Quebec

For more facts circle 258 on Reader Service card, p 107

Technical briefs

Begins on page 102

cation and (5) configuration of gear-housing wall.

Shrouds, closely fitted around gears, minimized the frothing. Lubricant is guided out of the shrouds and away from the point where gears mesh. This design modification cut gear-torque needs by 90% in one extreme case. *ASLE 61-AM 3C-1*

Molybdenum disulfide as an additive to improve the performance of an automotive multipurpose grease, *C D Thayer and H G Rudolph, Socony Mobil Oil Company, Inc*

Fleet field tests in various parts of the U.S. have shown benefits available from a moly additive in automotive greases. To get good test control, right sides only of some vehicles were treated with a moly-additive grease—left sides with a standard automotive grease.

Results: (1) Moly grease for chassis lubrication greatly improved steering. (2) Wear of moly-lubricated parts was cut in half. (3) Several difficult lube problems were easily solved with moly grease (nose bearings of torque converters are an example). (4) Fretting corrosion was cut to a minimum. Other case histories, together with resultant cost savings, confirm these tests. *ASME 61 MD-22*

To obtain complete text

Material for these abstracts comes from the following sources. Order complete publication from source, *not* POWER.

AIEE. American Institute of Electrical Engineers, 33 W 39th St, New York 18, N.Y. Members, 50¢; nonmembers, $1.00.

ASME. American Society of Mechanical Engineers, 29 W 39th St, New York 18, N.Y. Members, 50¢; nonmembers, $1.00.

APC. Contact American Power Conference, Illinois Institute of Technology, Technology Center, Chicago 16, Ill. Papers will be published as a book: price, $8.00.

ASLE. Contact American Society of Lubrication Engineers, 5 N Wabash Ave, Chicago 2, Ill. Members, 50¢; nonmembers, 75¢.

Your service center for FREE data

Either of the no-postage Reader Service cards below and p 107B will bring you information on any new equipment listed or product advertised, plus new literature for your files

- **Study new equipment** described in this issue starting on p 122. Circle numbers on card corresponding to items listed
- **Check new literature** available this month beginning on p 107A. To get your personal copies use the card below
- **Read advertisements** and note number listed under each ad. Circle ad numbers on card for complete details
- **Print your name and company on front of card**

Aug 1961 issue Circle numbers below for FREE data **Card void after Nov 1, 1961**

PLANT EQUIPMENT in the news this month, starting on p 122

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75
76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

NEW LITERATURE listed in this issue, starting on p 107A

101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125
126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150
151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175
176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200

ADVERTISED PRODUCTS appearing throughout the issue

201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225
226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250
251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275
276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300
301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325
326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350
351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375
376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400
401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425
426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450

SEARCHLIGHT SECTION for used and rebuilt equipment, starting on p 197

500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524
525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550

SAVE $4 ON YOUR OWN SUBSCRIPTION TO POWER
Yes, start sending my personal copies: U.S. 36 issues for $6 ☐ Canada, $10 ☐
Bill me later ☐ Bill my company ☐

NOTE: Fill in your name and business address on other side of card →

New free literature

General equipment and key materials for systems engineering

101 **Colloidal natural graphite** for lubrication and other uses is available in oils, water, synthetic esters and volatile carriers. 4-p bulletin is available from The Joseph Dixon Crucible Company

102 **Engine compressors** are 2-, 4- and 6-cylinder balanced-opposed units in 200- to 1000-bhp range. 4-p brochure is available from White Diesel Engine Div, The White Motor Company

• Instrumentation

103 **Pressure-measuring instrument,** tested to 2000 psi, serves as a low-pressure dead-weight gage or a high-range differential-pressure manometer. Mercury does not change with differential. 4-p folder is offered by ToPaz Inc

104 **Transmitters and recorders for** pressure and draft, fluid meters for recording, indicating and integrating are illustrated in 4-p circular G14-1. Bailey Meter Company

105 **Stroboscope** stops motion and measures rpm without contact over four scale ranges. 4-p pamphlet 781 is from Herman H Sticht Co, Inc

106 **Amplifier** for pH measurement can be installed on manufacturer's instruments. Spec sheet S914-1 gives details. Minneapolis-Honeywell Regulator Company, Industrial Div

107 **Instruments** for measuring, indicating, recording and controlling pressure and vacuum are subject of 32-p catalog C70-1a. Minneapolis-Honeywell Regulator Company

108 **Pressure regulators** — direct acting, reverse acting and control valves—are topics of 12-p bulletin 116. Flow coefficients for sizing water and steam valves are included. Manning, Maxwell & Moore, Inc

109 **Compensating level recorder** or indicator measures or controls boiler-drum water level. Spec sheet M31-2 is available from Bailey Meter Company

110 **Test gages,** depicted in 8-p publication 363, are used by engineers checking and calibrating pressure instruments in shop, lab and field. Manning, Maxwell & Moore, Inc

111 **Pressure regulator** with a 0.5- to 125-psi control range for steam, water, air, oil or gas service is subject of 8-p brochure J160-1 and spec sheet PNB5-61. OPW-Jordan

112 **Differential regulators** control atomizing-steam pressure at adjusted value higher or lower than fuel-oil pressure. Diaphragm-operated valves are detailed in data sheet. Atlas Valve Co

113 **Pneumatic receiver** has a 4-in. chart width. Chart drive is removable; you can refill inking system from front of the receiver. 6-p bulletin A134 is available from The Bristol Company

114 **Sight flow indicator** serves as a window in the pipeline. Speci-

---

PLEASE TYPE OR PRINT

Your Name .....

Position .....

Company .....

Co. Address .....

City and State.....

Is this your personal copy of POWER?

Yes ☐ No ☐

FIRST CLASS
PERMIT No. 64
NEW YORK, N. Y.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

POSTAGE WILL BE PAID BY—

Power

READER SERVICE DEPARTMENT

330 WEST 42nd ST.

NEW YORK 36, N. Y.

26th FLOOR

Air-conditioning systems 108
Electrical systems 108
Steam, hot-water systems 110
Fluid-handling systems 112
Nuclear systems 112
Mechanical-transmission systems 114
Energy-systems services 114

Circle key numbers, page 107, for your copies

fications are given in spec sheet from OPW-Jordan

115 **Rotameters** and tube and float meters are described in 20-p bulletin 520.100. Capacities range from 0.25 to 310 gpm of water, 1.1 to 1300 scfm of air. Wallace & Tiernan Inc

116 **Television monitors** are depicted in 4-p booklet ECL 92. Cabinet- and rack-mounted units have 14-, 17- and 21-in. screens. General Electric Communication Products Dept

• Maintenance

117 **Cutting downtime with metal** is topic of 6-p bulletin. Case histories cover flame spraying with metals in wire and powder form. Metco Inc

118 **Electroplating** without immersion tanks is described in 8-p booklet. Process permits application of 19 different platable metals and alloys. Sifco Metachemical, Inc

119 **Making maintenance parts** is topic of 16-p booklet which offers ideas on how to save time in machining parts, eliminate heat treating and quench cracks. Physical properties of steel bars used in parts are given. La Salle Steel Company

120 **Metal frames** are subject of 36-p construction and maintenance handbook 710. Bus duct, bar and distribution supports are shown, pipe, conduit and tubing data charted. Unistrut Products Company

• Piping, valves, fittings and specialties

121 **Pipe** OD and wall thickness from ⅛ to 42 in. are shown on chart, which relates ASA Standard information and schedule numbers. Midwest Piping Div, Crane Co

122 **Midget, packless solenoid valve** handles cryogenic liquids and gases from −100 F to almost absolute zero. Spec sheet V5126 is available from Automatic Switch Company

123 **Valves** — bronze, iron-body and cast-steel gate, globe, angle and check—are featured in 16-p catalog 10-B. R-P&C Valve Div, American Chain & Cable Company, Inc

124 **Standard, low-pressure valves**—gate, globe, angle and check — are subject of 16-p pocket booklet 1496-V. Comparison chart, application and installation info are features. Ohio Brass Company

125 **Diaphragm-actuated valve** handles high-pressure steam, water, gas, oil and air. Data sheet SRM 709.21 is from Republic Flow Meters Company

126 **3-way valve,** detailed in spec sheet, is for selecting, diverting, piloting or automatic cycling in air and nontoxic-gas service. G W Dahl Co, Inc

127 **V-band coupling** applications are discussed in 8-p booklet WB-1. Available coupling and flange configurations are pictured. Marman Div, Aeroquip Corporation

• Prime movers

128 **Pneumatic-engine control** systems shut down or give warning when measured variables don't

---

Aug 1961 issue **Circle numbers below for FREE data** **Card void after Nov 1, 1961**

PLANT EQUIPMENT in the news this month, starting on p 122

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75
76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

NEW LITERATURE lisfed in this issue, starting on p 107A

101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125
126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150
151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175
176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200

ADVERTISED PRODUCTS appearing throughout the issue

201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225
226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250
251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275
276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300
301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325
326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350
351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375
376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400
401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425
426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450

SEARCHLIGHT SECTION for used and rebuilt equipment, starting on p 197

500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524
525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550

SAVE $4 ON YOUR OWN SUBSCRIPTION TO POWER

Yes, start sending my personal copies: U.S. 36 issues for $6 ☐ Canada, $10 ☐

Bill me later ☐ Bill my company ☐

NOTE: Fill in your name and business address on other side of card→

function properly. 60-p catalog J is offered by Fulton Sylphon Div, Robertshaw - Fulton Controls Company

129 **Electronic governor senses speed** and load of steam and gas turbines and diesel engines rated 50 to 50,000 kw. Described in spec sheet GEA-7231 from General Electric Company

• Heat exchangers, condensers

130 **Coils,** finned tubes and gas-cooling and -heating equipment are illustrated in 6-p folder 900. Highlights finned-tube standards —materials, size, surface area. Brown Fintube Company

131 **Welded carbon-steel tubing** production and testing for heat-transfer applications is subject of 4-p circular. Revere Copper and Brass Inc, Rome Manufacturing Company Div

132 **Air-cooled condenser** for horizontal or vertical air flow is depicted in 4-p circular 2232. Section describes unit's propeller fans and motors. Westinghouse Air Conditioning Div

Air-conditioning systems

• Heating and ventilating

133 **Combustion-air heaters** are topic of 4-p publication FD 800. Steam-heating-coil and hot-water-coil designs are discussed. Buffalo Forge Company

134 **Fan - powered roof - ventilator** specifications are included in 16-p catalog A-112E. Vertical-discharge units and reversible ventilator which converts from exhaust to intake are covered. Hartzell Propeller Fan Company

• Controls

135 **Automatic chemical analyzers** monitor and record concentrations of low oxidants, nitrogen oxide or sulfur dioxide in the atmosphere. Data sheet is offered by Beckman Scientific and Process Instruments Div

Electrical systems

136 **Remote-indicating load-cell** applications are topic of 12-p manual R-2. W C Dillon & Co, Inc

• Transformation and conversion

137 **Variable transformer** has up to 3.75-amp output ratings with constant-current loads and up to 5.5 amp with constant impedance. 8-p brochure P6121 gives details. The Superior Electric Company

138 **Silicon rectifiers** rated 0.75 to 75 kw are subject of 6-p booklet GEA-7066. General-purpose, essential-service and synchronous-motor field-excitation units are covered. General Electric Company

• Distribution and protection

139 **Power plugs** rated 60 amp have molded-Neoprene body for safety. Spec sheet F54 is from Joy Manufacturing Company

140 **Shallow contact blocks, single** circuit, for oiltight pushbutton operators are pictured in data sheet GEA-7320. General Electric Company

141 **Plug-in equipment** supplies power to electrical-resistance strip heaters for preheat and stress

PLEASE TYPE OR PRINT

Your Name .....

Position .....

Company .....

Co. Address .....

City and State.....

Is this your personal copy of POWER?

Yes ☐ No ☐

FIRST CLASS
PERMIT No. 64
NEW YORK, N. Y.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

POSTAGE WILL BE PAID BY—

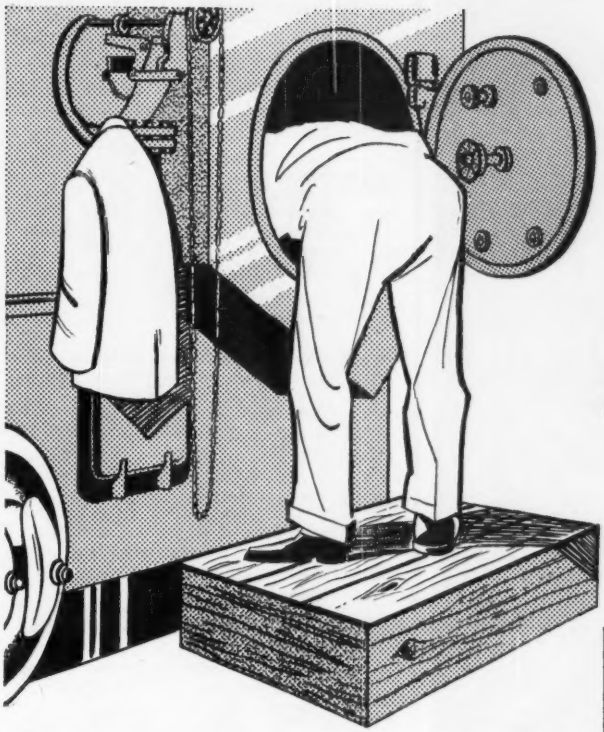
Power

READER SERVICE DEPARTMENT

330 WEST 42nd ST.

NEW YORK 36, N. Y.

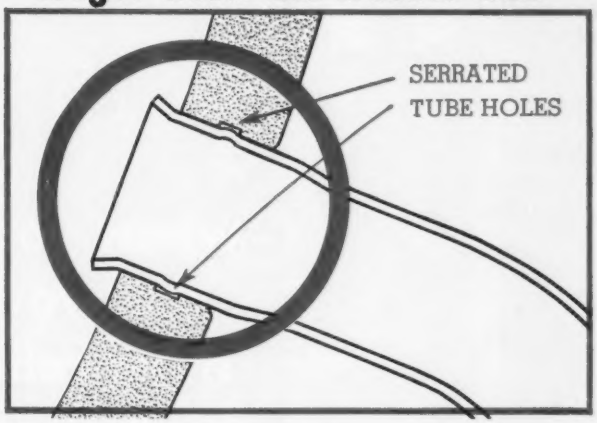
26th FLOOR



You'd have to CRAWL INTO THE BOILER to see these features which make SUPERIOR "TYPE D"

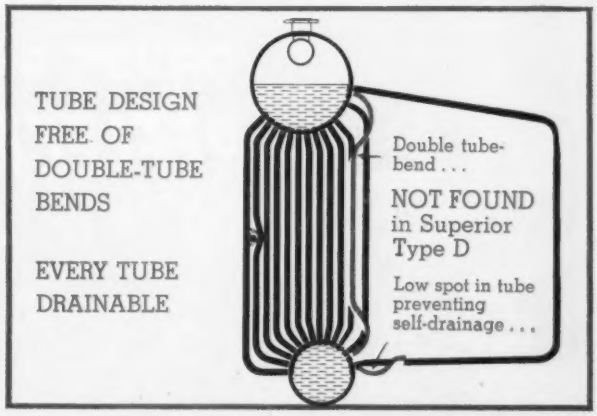
Completely Packaged Boiler

longer-lived and trouble-free

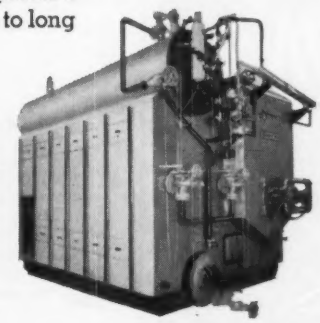


Even if you crawl in, you won't see the serrated tube-holes which provide protection from tube leakage and its resultant caustic embrittlement . . . yet, as you would expect in a quality boiler, they are part of the Type D Superior Packaged Boiler.

Another hidden quality feature is its tube design, shown at right. Note that there are no double tube-bends (shown in red) exposed to radiant heat . . . a characteristic of many water-tube boilers which increases susceptibility to scale formation. Note that every tube is self-drainable (eliminating need of separate blowing operation in cleaning). All tubes provide maximum vertical length with minimum number of bends.



Not all features of Superior's Type D which contribute to long life and trouble-free performance are obvious from the exterior. Some are buried deep inside the boiler . . . but they are there to assure you of the performance you have come to expect from Superior Packaged Boilers.



For condensed data describing the World's Most Complete Line of Packaged Boilers write today for Catalog S-11

Fire-Tube and Water-Tube PACKAGED BOILERS

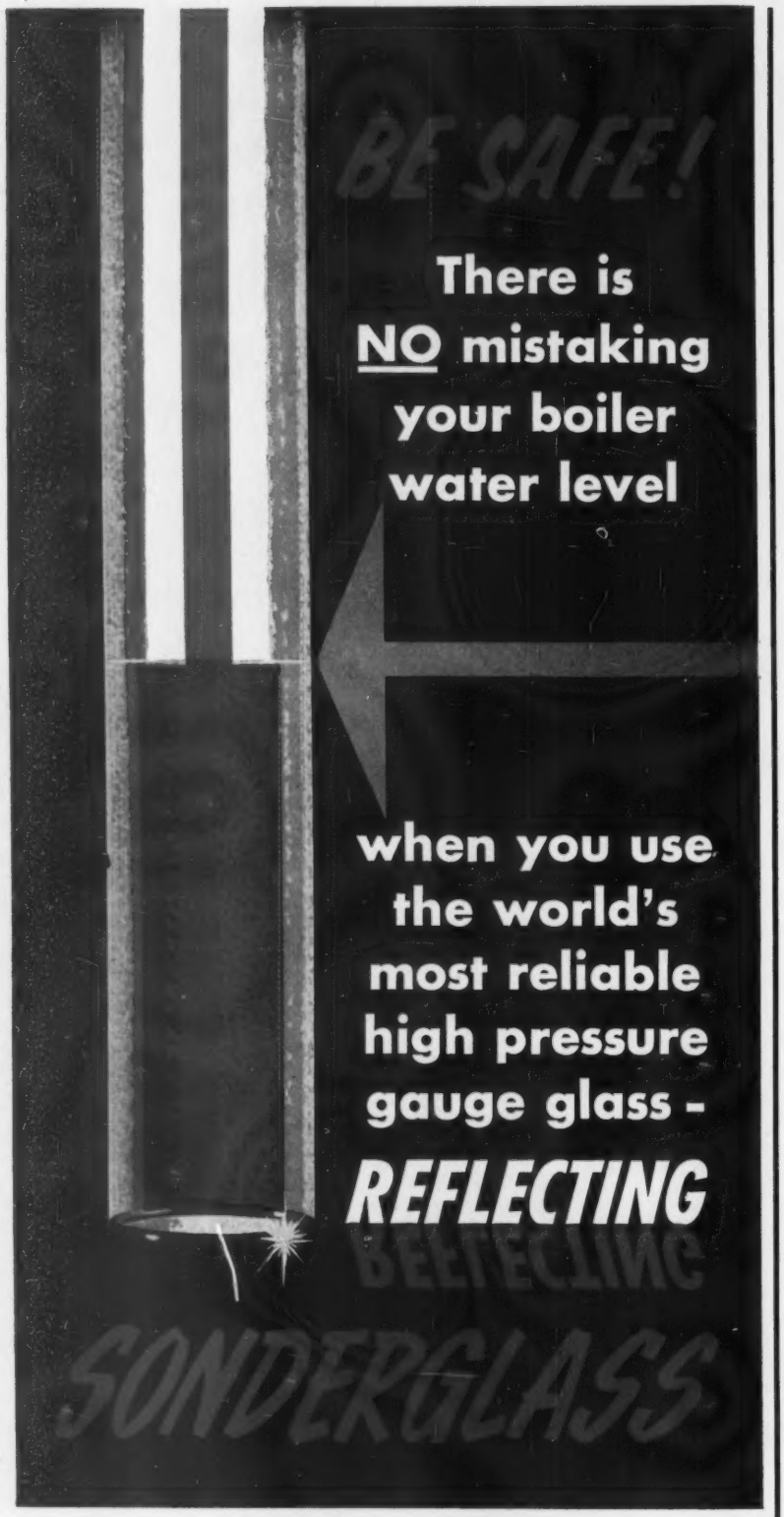
for STEAM or HOT WATER

SUPERIOR COMBUSTION INDUSTRIES INC.

TIMES TOWER, TIMES SQUARE, NEW YORK 36, N. Y.

SUPERIOR PACKAGED BOILERS ®

For more facts circle 259 on Reader Service card, p 107



Reflecting SONDERGLASS is the original magnifying redline gauge glass. Its fused double-layer construction resists alkali and acid, remaining clear and easy to read. SONDERGLASS has been tested to upward of 1,000 lbs., per sq. in. steam pressure and 4,000 lbs. hydraulic pressure. It has been subjected to 450° oil baths and repeatedly plunged into cold water without spalling or cracking. Provide your men and boilers with the **extra margin of safety** by using only SONDERGLASS. Sold by leading industrial distributors.

A. W. CHESTERTON CO., Everett 49, Massachusetts

Free literature

Begins on page 107A

relief in welding. Data sheet is issued by J B Nottingham & Co, Inc

142 **600-v switchgear** with circuit breakers are described in 20-p bulletin 3200-1A. Provides information on breakers and switchboards from 225 to 4000 amp. I-T-E Circuit Breaker Company

• **Application**

143 **Sealed-beam floodlights** accommodate lamps from 75 to 500 w. Foot-candle charts and selection info are included in 12-p brochure 2727. Crouse-Hinds Company

144 **"High-voltage testing:** it can be nondestructive" is title of 4-p reprint 5-15.4. Insulation breakdown and current-limiting as a prevention measure are discussed. Associated Research, Inc

145 **H-v test sets**—insulating-oil and multiple-output dielectric, ac-dc, 150-kv and 15-kva ac—are listed in 8-p catalog. Peschel Electronics, Inc

Steam and hot-water systems

146 **Airfoil centrifugal fans** for furnaces, packaged boilers and air drying are available in capacities from 15,000 to 450,000 cfm. 4-p booklet 1122 is available from Westinghouse Electric Corporation, Sturtevant Div

147 **Jet blowers** use compressed air or steam pressure to move ventilation or circulation air; blast nozzles are used in ducts and stacks at very low drafts. 8-p bulletin 4AB is offered by Schutte and Koerting Company

148 **Air-driven soot blower** is described in 8-p bulletin 1073. Cleaning pattern of dual-motor drive and multihelix jet paths is diagramed. Blaw - Knox Company, Copes-Vulcan Div

• **Boilers**

149 **3-pass boilers** rated 243,000 to 1,350,000 Btu per hr are illustrated in 8-p brochure 549B. Selection data for available heating coils and i-d fans is given. American-Standard Industrial Div

150 **Watertube packaged boiler** with two drums, for oil or gas firing, is subject of 16-p catalog SB63. Design and construction of 5000- to 100,000-lb-per-hr units are shown. Erie City Iron Works

• **Fuel and fuel handling**

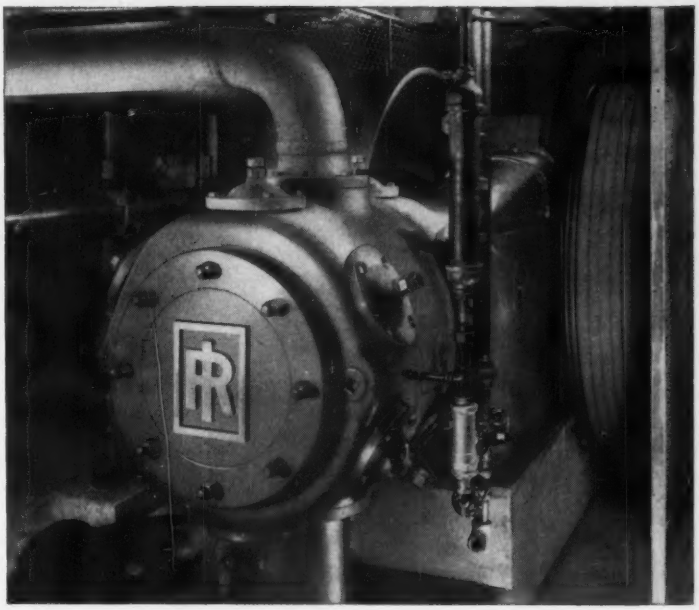
151 **Coal-preparation** pocket manual 561 covers preparation equipment in its 156 pp. Second section contains engineering data and reference tables. McNally Pittsburg Manufacturing Corporation

continued

IN I-R COMPRESSORS,

TIME TELLS

THE DIFFERENCE



This I-R non-lubricated compressor has operated

34,640 HOURS

with original wear ring—and still going strong!

In July, 1950, a prominent manufacturing company purchased an Ingersoll-Rand ES-NL non-lubricated compressor to supply oil-free air for its Cincinnati plant. At this writing, the unit has operated for 34,640 hours, at an average of 70 hours per week, with the original piston and wearing ring – and it's still going strong.

The piston compression rings were changed once, during routine inspection in 1955.

It takes a special breed of compressor to withstand thousands of hours of continuous service without lubrication of any kind. It's one of the toughest jobs a machine is asked to do, and dependability is the first requirement. Of course, many different factors determine the life of non-lubricated equipment – condition of gas handled, pressures, operating practices, type of service – but you'll find that Ingersoll-Rand NL compressors have the best reputation for dependability in all kinds of jobs.

Ingersoll-Rand introduced the non-lubricated compressor principle in 1933, and today builds the widest range of types and sizes. The Ingersoll-Rand air-cushioned NL Channel Valve is the only valve designed specifically for non-lubricated operation. Ingersoll-Rand NL compressors have a number of other exclusive *Extra-Value* features, and each unit is engineered for its specific job.

You'll find that I-R is best prepared to handle your compressor requirements, with the most complete line of compressors – in reciprocating, centrifugal, axial-flow, rotary and thermal types. There are units from ½ to 25,000 hp, for pressures from one micron to 125,000 psi. Call your I-R man today for help on your job.

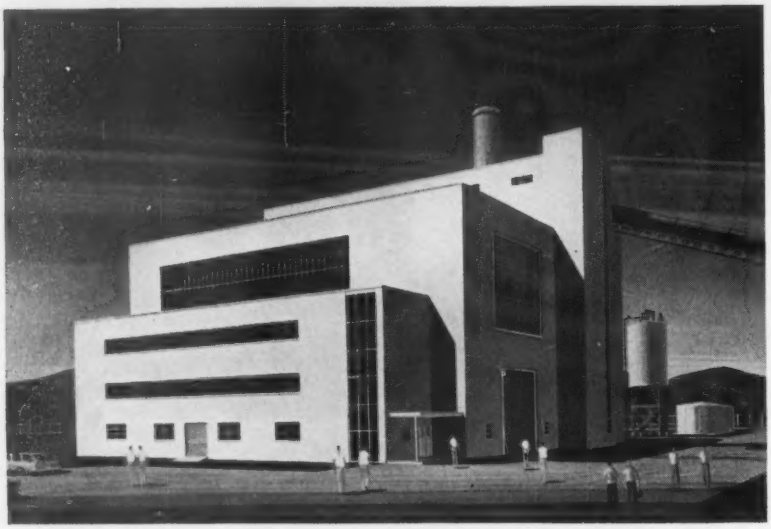
Ingersoll-Rand

126A1 11 Broadway, New York 4, N. Y.

The World's Most Comprehensive Compressor Experience

For more facts circle 261 on Reader Service card, p 107

POWER



BY DESIGN

Thermal, hydro electric, nuclear or internal combustion . . . Kuljian engineers are specialists in the design and development of modern power facilities.

Over 30 years' experience in the power field can be focused on every phase of your new project or expansion program. Write for brochure detailing specialized Kuljian services for industry and utilities.

WE DESIGN AND CONSTRUCT

Power Plants • Public Works • Processing Plants
Oil Refineries • Chemical Plants • Textile Plants
Airports and Facilities • Expressways • Highways
Institutions • Military Installations

The Kuljian Corporation

engineers • constructors

1200 NORTH BROAD STREET • PHILADELPHIA 21, PA.

DESIGN • ENGINEERING • PROCUREMENT • CONSTRUCTION • REPORTS

For more facts circle 262 on Reader Service card, p 107

Free literature

Begins on page 107A

152 **Continuous blending** of fuel oil to attain desired viscosity is subject of 4-p folder 90-29-03. Fischer & Porter Co

Fluid-handling systems

153 **Hazardous-waste disposal** safety guide SG-9 outlines open and incinerator burning, sewer and burial disposal. Price: 20¢. Manufacturing Chemists' Association, Inc

• Pumps

154 **End-suction centrifugal pump** has 5- to 775-gpm capacity, −350 to +500 F temperature range. Bearing-life information, pressure-temperature chart and frame-selection table are chapters of 16-p bulletin 725.1. Goulds Pumps, Inc

155 **Pump motors** and drives are subject of 20-p brochure F-2002. Units are indexed according to construction, enclosure and thrust —then you turn to chosen motor or drive's rating, description and dimensions. U. S. Electrical Motors Inc

156 **Ball bearings** for centrifugal pumps are topic of bulletin 6. Discusses axial- and radial-thrust problems. Peerless Pump, Hydrodynamics Div, Food Machinery and Chemical Corporation

157 **Packaged centrifugal pump** with 400-gpm capacity is a close-coupled end-suction type. Performance is charted in 4-p folder 117 from Aurora Pump Div, The New York Air Brake Company

• Controls

158 **Flow-responsive equipment** combines fluid meters and proportioning pumps for continuous process. Units are controlled from a single source. 4-p booklet 1400-20-1 is available from B-I-F Industries

159 **Hydraulic pilot** for diaphragm-valve control is diagramed in fact sheet available from Atlas Valve Company

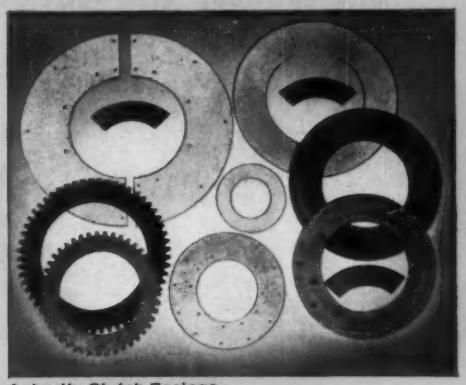
Nuclear systems

160 **Rod type nuclear-fuel-element** fabrication for power reactors is covered in revised 8-p bulletin GEA-6762B. Current research, testing and fuel-service programs are included. General Electric Company

161 **Isotope chambers** for gamma radiography are subject of 6-p brochure. Specifications for chambers using iridium 192 and cobalt 60, radiography training, consulting and engineering services are covered. Philips Electronic Instruments

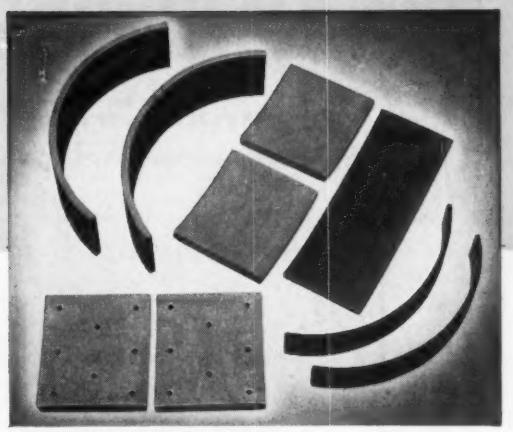
162 **Nuclear data system** bulletin 101 gives specifications on 3600-point

Ankorite Woven Brake Lining



Ankorite Clutch Facings

Busy Engineers Specify Dependable...



Ankorite Molded Brake Blocks

ANKORITE FRICTION MATERIALS

It pays dividends in time and money to select brake linings and clutch facings that are engineered to meet the toughest of service demands. In this class, Ankorite Friction Materials are second to none. For example:

ANKORITE BRAKE LININGS insure smooth safe stops . . . will not score your drums. They last longer—speed braking operations. Heavy duty and lighter duty types are available for all uses—dry or in oil, indoors or outdoors.

ANKORITE BRAKE BLOCKS—endless or molded in segments—are made from the finest Canadian asbestos with metal insertion. Designed for all type shoes and bands—ideal wherever hard, tough, long wearing blocks are required.

ANKORITE CLUTCH FACINGS, gear tooth clutch gears, cone types, and facings of many odd shapes and sizes are made to machined accuracy for the most exacting needs.

For every requirement, there is an Ankorite Friction Material with the ideal friction coefficient. For data, see your Anchor Representative, or contact the Anchor General Office, today.

DISTRICT OFFICES

BALTIMORE, MD.	MINNEAPOLIS, MINN.
BOSTON, MASS.	MONTREAL, CANADA
BUFFALO, N.Y.	NEW ORLEANS, LA.
CHICAGO, ILL.	NEW YORK, N.Y.
CINCINNATI, OHIO	PHILADELPHIA, PA.
CLEVELAND, OHIO	PITTSBURGH, PA.
DAYTON, OHIO	SAN FRANCISCO, CAL.
DETROIT, MICH.	SEATTLE, WASH.
HOUSTON, TEX.	SPOKANE, WASH.
INDIANAPOLIS, IND.	ST. LOUIS, MO.
LOS ANGELES, CAL.	TOLEDO, OHIO
MILWAUKEE, WIS.	WILMINGTON, CAL.

Find It Fast in The "Yellow Pages"

THE ANCHOR PACKING COMPANY

GENERAL OFFICES . . . PHILADELPHIA, PENNSYLVANIA
FACTORIES . . . MANHEIM, PA., ELKHART, IND., MONTREAL, CAN.

FIBROUS AND METALLIC PACKINGS FOR EVERY INDUSTRIAL PURPOSE

For more facts circle 263 on Reader Service card, p 107

This LITTLE trap does a BIG trapping job— and reduces the cost of discharging condensate

NEW NICHOLSON N-150 THERMOSTATIC STEAM TRAP

...All steel construction for rugged durability.

...Design simplified for quick, low cost maintenance.

...Compact, lightweight, easily installed. Can be inspected without breaking pipe connections.

...Equipped with Nicholson steam-saving Baffle*.

For lowest cost-per-pound of condensate handled, this trap is by far your best buy. Like all Nicholson Thermostatic Traps, it opens ONLY when necessary . . . that is, when sufficient condensate collects in trap body to surround the Monel bellows . . . ONLY then does the pressure inside the bellows reduce below line pressure, the resulting differential causing bellows to contract and instantly activate complete discharge. Body is cast steel and cover forged steel. Cover screws, valve and valve seat are hardened stainless steel. Just *one* working part, so maintenance is practically nil. In ½" and ¾" sizes. For pressures from vacuum to 150 psig. Write for details, including the name of the Nicholson man in your area.

*Patent applied for

W. H. NICHOLSON and COMPANY

12 Oregon Street • Wilkes-Barre, Pa.

Our 80th Year

Free literature

Begins on page 107A

high-speed monitor for nuclear-reactor control in its 4 pp. Monitor Systems, Inc

Mechanical-transmission systems

163 **Power-drive flexible couplings** are charted in 4-p folder J-23. Describes double- and single-engagement, extended and mill-motor couplings. Hewitt-Robins, Jones Machinery Div

164 **Takeups** with sleeve, ball or roller bearings in seven frame sizes are topic of 16-p brochure 2741. Link-Belt Company

165 **Nylon-polymer-core belting** is featured in 12-p catalog. Graphs help determine proper belt type; width and tension are charted. Extremultus, Inc

166 **Sleeve bearings,** self-aligning and -lubricating, come in flanged and pillow-block types for service up to 1000 F, under water or in corrosive conditions. 6-p folder 2823 is from Link-Belt Company

167 **Steel-belt-conveyor** applications are depicted in 8-p booklet. Sandvik Steel, Inc

Energy-systems services

168 **Techniques** used in followup geophysical-investigation programs for underground-storage facilities are described in 8-p brochure. Mineral Fuels Div, Geotechnics and Resources, Inc

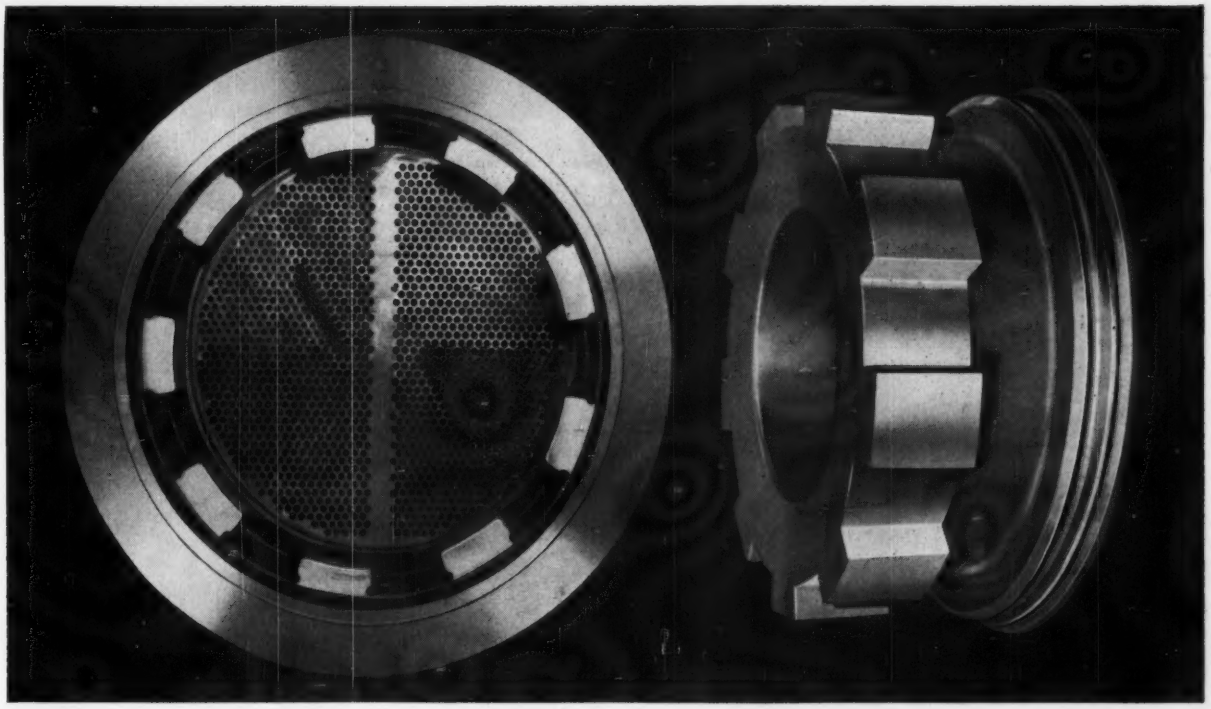
169 **Standards** catalog for 1961 has index and listing of publications in standardization field. American Standards Association

EDITOR'S NOTE: *The following bulletins may be requested directly from the manufacturer. Write on company letterhead to addresses listed below:*

★ **Heat exchangers** are detailed in 24-p catalog 101. Units are available in 150-, 300- and 450-lb tube- and shellside pressures; 2, 4 or 6 passes tubeside. The Griscom-Russell Co, 185 Wetmore Ave, Massillon, Ohio

★ **"Silicones** for electrical insulation" is title of 8-p publication CDS-288. Electrical and electronic applications for silicones are charted. General Electric Company, Silicone Products Dept, Waterford, N. Y.

Film series of three helpful tips on safety in the factory were made at the Appleton Electric Company factory. Films deal with typical hazards and ways to protect men from harm.



Simplicity and Easy Maintenance

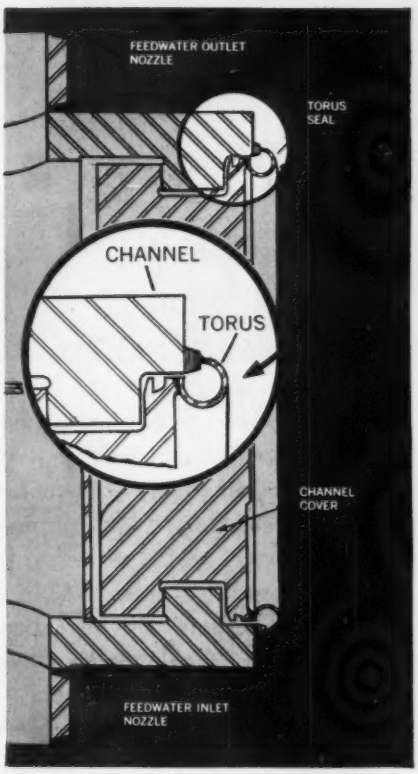
win quick acceptance by Utilities for new FW Feedwater Heater Closure

U.S. utilities had their first look at this new gasketless Breech-Lockhead for feedwater heaters last year. Decisions to buy followed quickly among leading utilities including Pacific Gas and Electric, Omaha Public Power District, Toledo Edison Company, and Gulf States Utilities.

Why such fast acceptance from an industry which must weigh every advance with extreme care? Because the FW Breech-Lockhead closure combines two proven principles—the torus and the breech-lock—the best way yet devised for achieving simplicity and ease of maintenance with a *positive seal*. The torus, welded to the edges of the channel and cover, provides a fully *leakproof seal independent of hydrostatic pressure.*

Disassembly and reassembly of the closure is quick and easy. Since the torus is only a seal it is readily cut away from the channel, and remains attached to the pressure cover. The pressure cover is then quickly removed. Simple tools, supplied with the heater, make cutting, removal, replacement and rewelding a routine procedure.

If you are now considering feedwater heaters, get full technical information on this new Foster Wheeler Breech-Lockhead. It will simplify your maintenance. Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, N.Y.



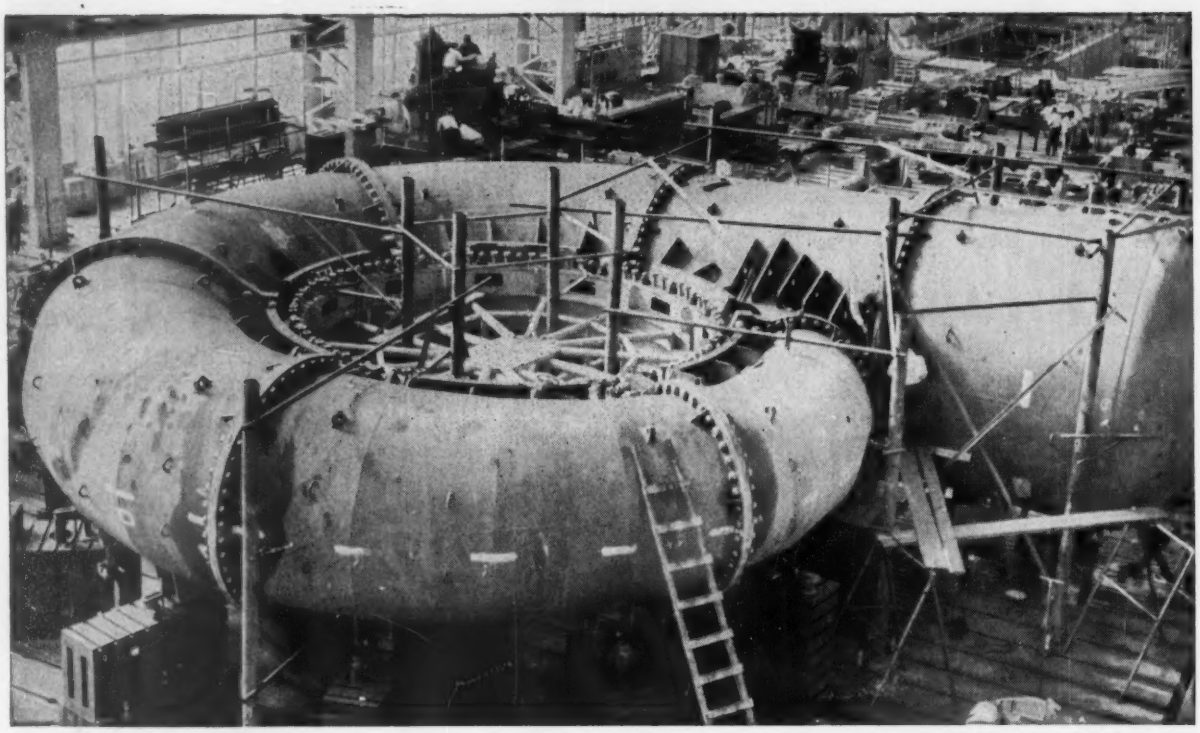
FOSTER WHEELER

NEW YORK TORONTO LONDON PARIS MILAN TOKYO

For more facts circle 265 on Reader Service card, p 107

HITACHI

now completing the first hydraulic turbines for Thailand's Yanhee Project



Shop tests were recently completed on the spiral casing for the first of two 115,000 HP Francis-type turbines being completed by Hitachi for Thailand's Royal Irrigation Department. These will be the first of the planned 8 sets of generating units to be installed at the downstream of the Bhumiphol Dam, as part of the Yanhee Multipurpose Project which will commence operation in 1963 and eventually supply 560,000 kW of power to Bangkok and Thonburi. The vertical shaft Francis turbines have been designed to deliver 115,000 HP under the effective head of 112m and for a speed of 150 rpm. Their spiral casings, with inlet diameter of 4150mm, will each be divided into 7 sections for transportation by barge up the Ping River to the site.

Hitachi, Ltd.
Tokyo · Japan
Cable Address: "HITACHY" TOKYO

IT'S NOT TOO EARLY TO THINK OF NEXT WINTER'S COAL HANDLING PROBLEMS

PENNSYLVANIA FROZEN COAL CRACKERS WILL PREVENT

- **Hopper jams**
- **Overloaded conveyors**
- **Slowdowns**
- **High labor costs**

Get ready *now*—for the worst conditions next winter can bring. Investigate Pennsylvania Frozen Coal Crackers.

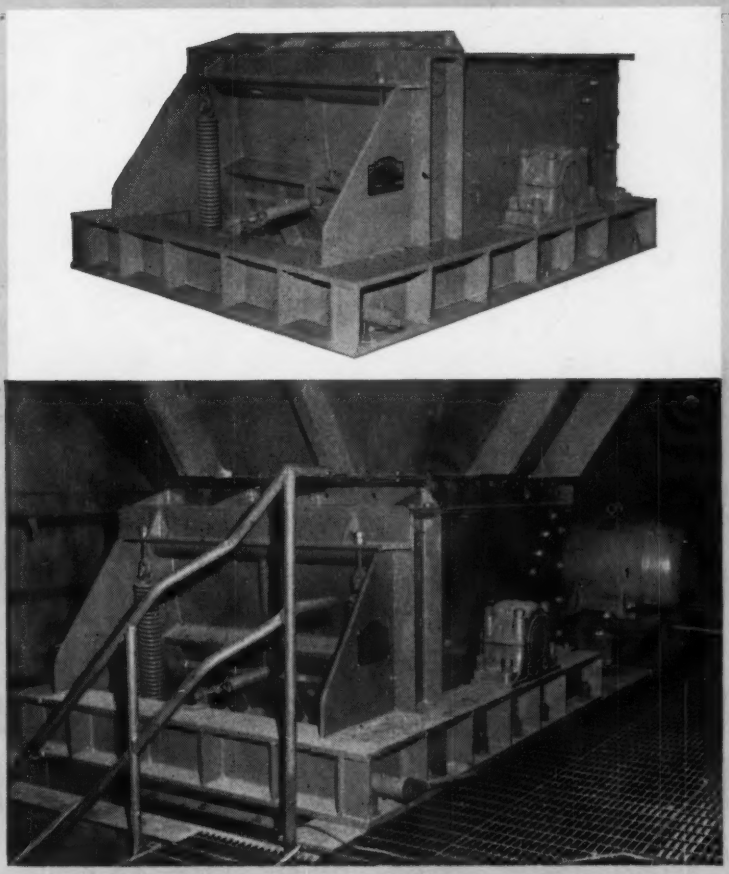
These are the crushers especially designed and widely used for handling frozen coal at track delivery points and storage yards.

OPERATION

Wide feed openings permit use of *open-throated hoppers.* Frozen masses of coal are dumped (with rotary car dumpers) directly into hoppers. No need for grates. Frozen coal works its way freely to the hopper bottom where the crackers' special teeth break it up.

Result—uniform product with limited top-size and minimum fines is fed conveyors, providing protection from overloads . . . insuring continuous flow of coal.

Breaker plates can be opened in warm weather, permitting coal to pass without operating crusher.



30 x 60 Single Roll Pennsylvania Frozen Coal Cracker in service at Merrimack Steam Station, Public Service Company of New Hampshire, Concord, N.H.

OTHER FEATURES

Built-in tramp iron protection. Low head room requirements. Easily adapted to existing hoppers. Capacities up to 1200 TPH. Available in single or twin units.

Write today for new Pennsylvania Bulletin 2013 . . . or call your nearest Pennsylvania representative.

PENNSYLVANIA CRUSHER DIVISION
BATH IRON WORKS CORPORATION
WEST CHESTER, PENNA.

★ ★ ★

Over 50 years concentrated experience in mechanical reduction. Call on Pennsylvania with your next crushing problem. Representatives from coast-to-coast.

PENNSYLVANIA CRUSHERS
BATH-BUILT

Monel alloy feedwater heater tube (shown emerging at lower right) is being ultrasonically scanned. If imperfection shows up, signal stops drive and operator shunts tube into discard rack.

How the Immerscope test assures trouble-free Monel tubes for high pressure feedwater heaters

With an ultrasonic ear sharply tuned, the Immerscope you see above inspects every inch of every length of Monel* nickel-copper alloy feedwater heater tubing produced at Huntington Alloy Products mill.

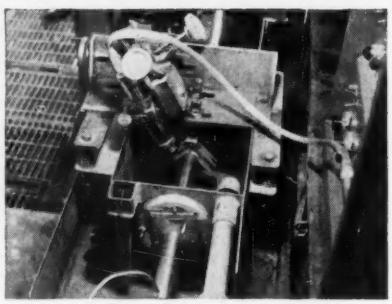
And this is only one of a number of places where forgings, extruded tube shells, and the tubes in various dimensions are carefully checked.

In the Immerscope test, a probe beams ultrasonic waves into the rotating tube as it is driven slowly through water. Any deviation from standard is translated into a pip on an oscilloscope. Just one pip and the drive cuts out. A horn blows alerting the operator to remove the tube.

Precision-made and precision-tested, Monel alloy tubes meet today's needs – they have the strength it takes to handle high pressures and temperatures in modern steam plants. Monel alloy tubes are corrosion-resisting and have good heat transfer properties. They are workable and weldabie—easily joined to tube sheets.

Keep Monel alloy in mind, whether it be in the designing stage or retubing. Huntington supplies tubes in lengths up to 85 feet, pre-bent if desired. Prompt delivery can be assured on urgent jobs. *Inco trademark

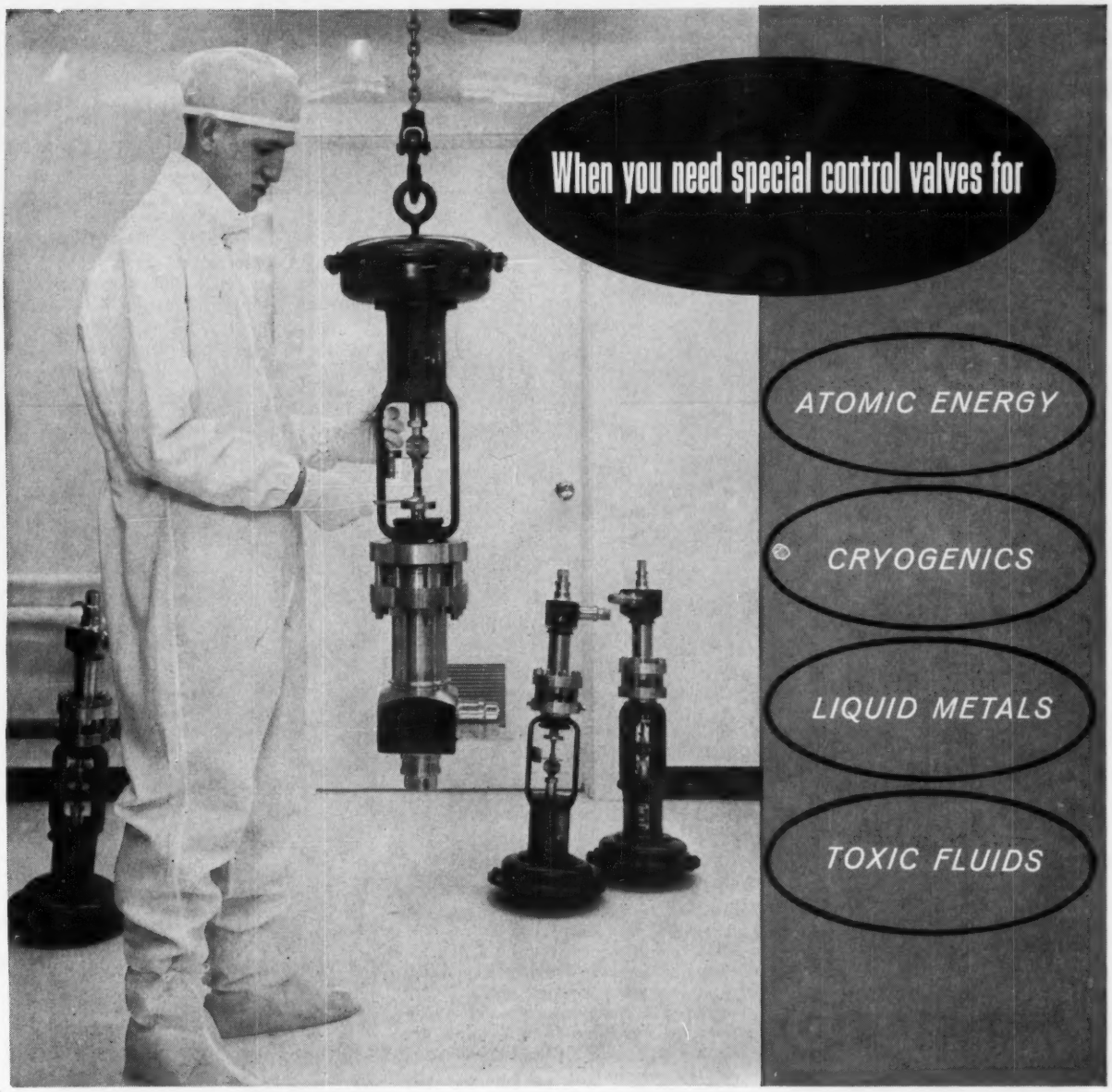
HUNTINGTON ALLOY PRODUCTS DIVISION
The International Nickel Company, Inc.
Huntington 17, West Virginia



Ultrasonic probe sends sound waves into the metal where waves bounce back and forth between inner and outer surface of tube (shown left) until 100% of tube has been inspected.

MONEL®

For more facts circle 268 on Reader Service card, p 107



Fisher facilities and engineering skill are at your command

Typical of the special control valves assembled in the spotlessly clean Fisher white room is the Type SS-30, a high temperature angle body for controlling liquid metals at pressures up to 250 psi and temperatures of 1500° F. The SS-30 is also used in the atomic energy field and for control of toxic fluids in the chemical industry. Made of forged or bar stock material, the SS-30 has seal-welded joints, Stellite faced valve plug and seat, and bellows seal to prevent valve stem leakage. Stainless steel valve body is self-draining in both vertical and horizontal positions. SS-30 is tested by mass spectrometer when required to meet critical body and seat leakage rates.

Pressurized rooms, filtered air, pre-cleaned tools, and properly attired technicians will keep your equipment immaculate until capped and sealed for shipment. Fisher Governor Company, Marshalltown, Iowa. Plants in Woodstock, Ont., Rochester, England. Butterfly Valve Division: Continental Equipment Co., Coraopolis, Pa.

If it flows through pipe anywhere in the world ...chances are it's controlled by.....

FISHER®

SINCE 1880

For more facts circle 269 on Reader Service card, p 107

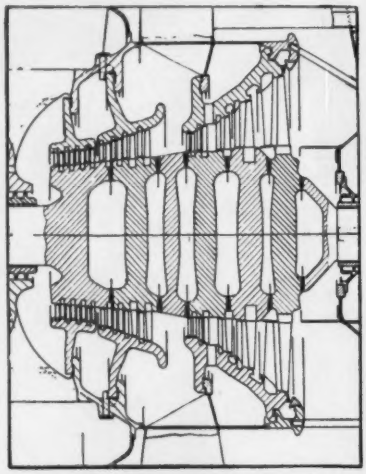
Welded sectional rotors for steam turbines

By N. K. Halsteen, Project Engineer, Brown Boveri Corp.

BROWN BOVERI

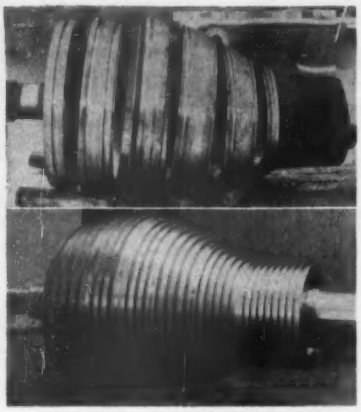
The manufacture of large, solid, one-piece rotors presents problems in detection and inspection of flaws, often resulting in the difficult choice of scrapping an expensive forging or completing the rotor with a "patch" or with an internal flaw whose effect in operation cannot be predicted with certainty. In use, the mass of a solid rotor also causes difficulty in maintaining tight shrink fits for the wheels and prevents uniform heat distribution for short start-up or shut-down schedules.

To avoid these difficulties, Brown Boveri developed a rotor made of forged discs and hollow, bell-shaped end sections welded together at the rims, forming a light, strong, rigid unit.



Cross-section of low-pressure stage showing welded segments of rotor shaft.

How Brown Boveri sectional rotors are made



Above: Sections of shaft ready for welding.
Below: The shaft after welding, heat-treatment and machining.

The rotor is assembled vertically on a turntable, the sections being centered by spigots. As the workpiece rotates past welding heads, the butting surfaces are welded. Welds are made at several points around the section at the same time—to prevent distortion. The welding is done automatically by the tungsten inert-gas process . . . providing homogeneous welds free of slag.

After a few layers of weld, the root is checked with gamma rays. If approved, the welding is completed.

After a final ultrasonic test, the welded area is given stress-relief heat treatment, with the rotor in vertical position. Machined rotors are tested at 40% overspeed before blading . . . also balanced statically and dynamically after blading.

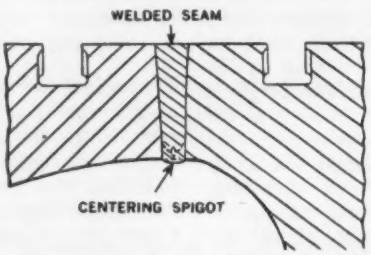
Advantages of sectional rotors

Because of the relatively small size of each section, forging conditions meet ideal metallurgical requirements. Inspection can be complete. Doubtful sections are scrapped without any attempt at "patching." Possible asymmetries resulting from forging are cancelled by the chance disposition of individual sections.

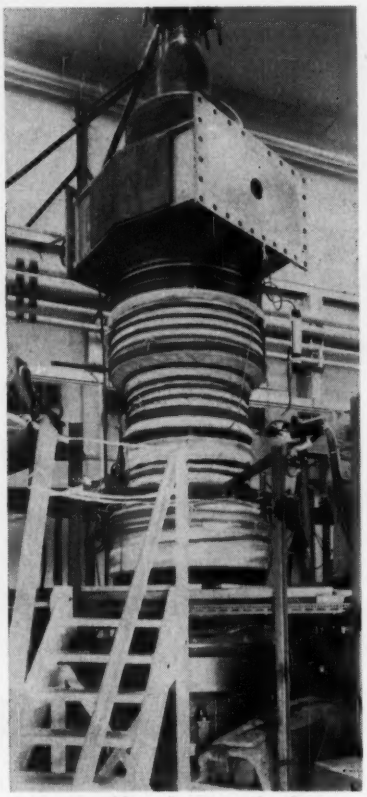
The stress-relieving procedure practically eliminates asymmetrical stresses.

The low mass of the rotor results in a favorable mass ratio between rotor and casing . . . with far less critical expansion differentials during sudden load changes or short start-up and shut-down schedules.

As evidence of its sound engineering. the Brown Boveri sectional rotor design has been used for over 30 years in several thousand rotors—and without a single explosion or other serious rotor failure.



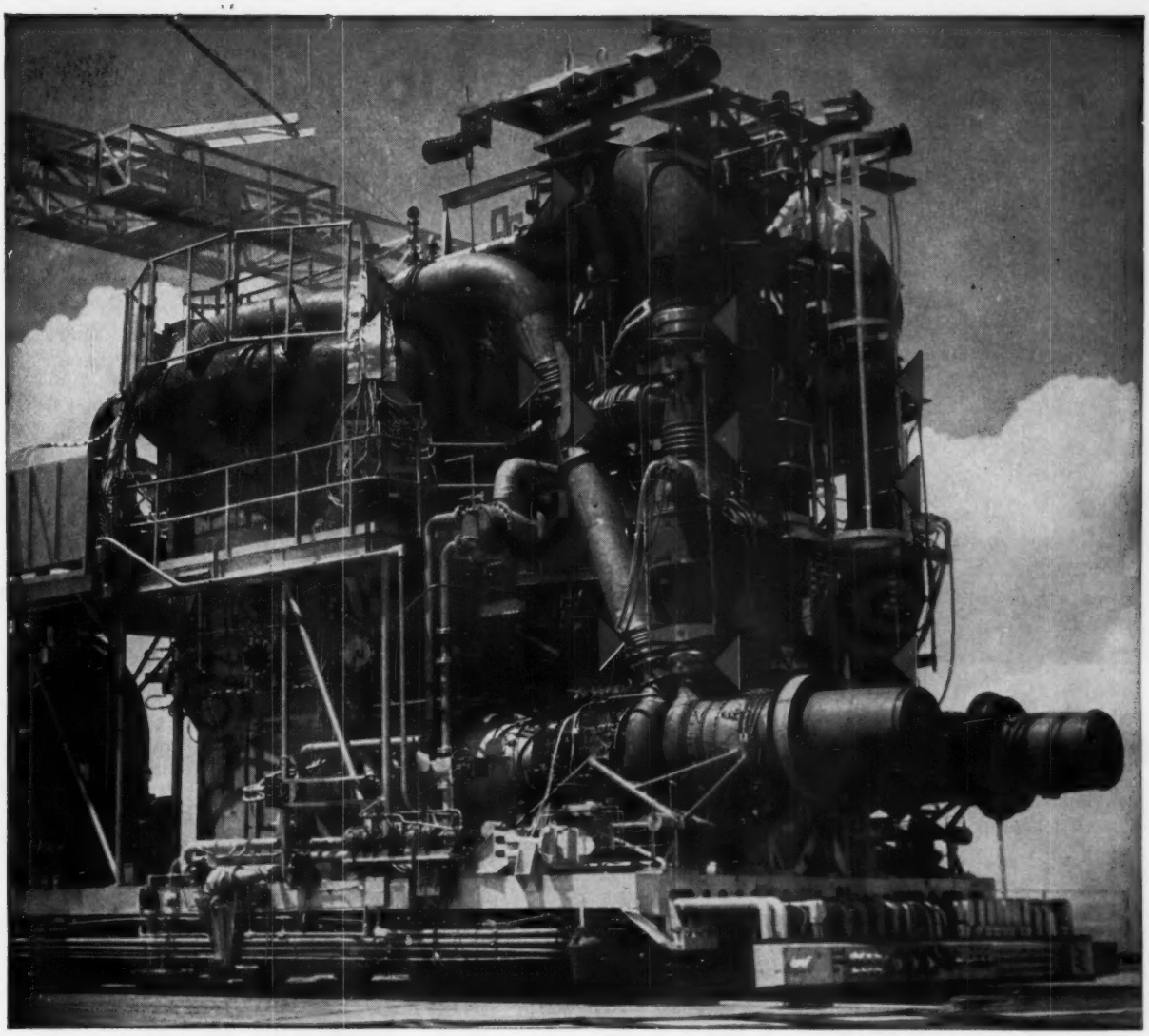
Cross-section of weld seam. Note uniform thickness of rims at weld — for minimum thermal stresses.



Automatic welding of sections. Also shown are insulating blanket and induction heating cable for pre-heating before welding and stress-relief treatment after welding.

Other features of Brown Boveri steam turbines: an all-hydraulic governing system without rods, levers or mechanical joints subject to wear and resulting inaccuracies . . . and an unequalled reliability of service illustrated by many Brown Boveri turbines built 40 to 45 years ago and still in continuous operation.

BROWN BOVERI Brown Boveri Corp., Dept. P8, 19 Rector Street, New York 6, N.Y. Agents in 27 U.S. cities



Where expansion joint reliability really counts... YOU FIND ZALLEA

Eighteen Zallea Expansion Joints protect all the piping between compressor, reactor and turbine in General Electric's Heat Transfer Reactor Experiment (HTRE). Sizes range from 18-in. to 30-in. diam. Temperatures are 500 F and 1500 F at 53 psig.

Objectives of HTRE were to develop and test a complete aircraft nuclear power plant system, to determine operating characteristics, and to verify the design of a direct-air-cycle nuclear propulsion system. As in any research involving unknown quantities (in this case the heat source) a basic requirement for all system components was *maximum reliability*. The results of HTRE were successful. Objectives were accomplished. The integrity and life of all system components were verified.

This is another example of Zallea competence in the nuclear field. In fact, Zallea has provided the large majority of all the expansion joints used in atomic, nuclear and missile projects. Our work with almost every major engineering and manufacturing firm in these fields has given us an unequalled background of experience and engineering capacity. It can give you important savings in time and investigation when expansion is involved in piping systems or tanks.

Write for Catalog 56, which contains complete and comprehensive engineering data for Expansion Joints from 3-in. to 50-ft. diam., pressures to 3600 psi, temperatures to 1600 F.

ZALLEA BROTHERS, Taylor and Locust Streets, Wilmington 99, Delaware.

Zallea FOR MAXIMUM RELIABILITY

WORLD'S LARGEST MANUFACTURERS OF EXPANSION JOINTS

For more facts circle 271 on Reader Service card, p 107

Plant equipment news... Your

For more data on these developments, circle key numbers on Reader Service card, p 107

L-v switchgear features Power-to-Grow

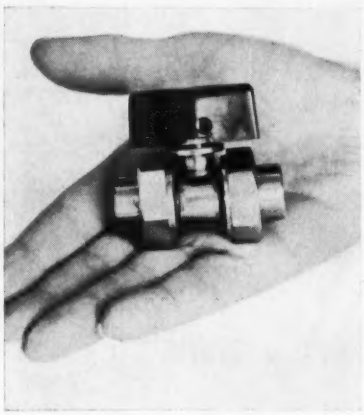
1 • At a recent press conference, Gordon Benson, Federal Pacific Electric Company marketing manager, introduced l-v switchgear uprated to meet modern electrical-system requirements. FP-500 series offers increased-frame-size breakers in continuous-current ratings of 400, 800 and 2000 amp; FP-100 series offers two frame sizes in 3000- and 4000-amp ratings at 600 v. Uprated frames allow greater load growth with a given size. Raising interrupting capacities of FP-500 units to 50,000-amp asymmetrical and FP-100 to 100,000 amp gives user advantages of fully rated system at prices of a cascade system, Benson stated. FP-500 series breakers can mount four-high. Compartment of 2000-amp breaker will accommodate smaller-frame-size units for future uprating. Tripping device is adjustable to new load requirements.—Federal Pacific Electric Company

Buy computer off-the-shelf

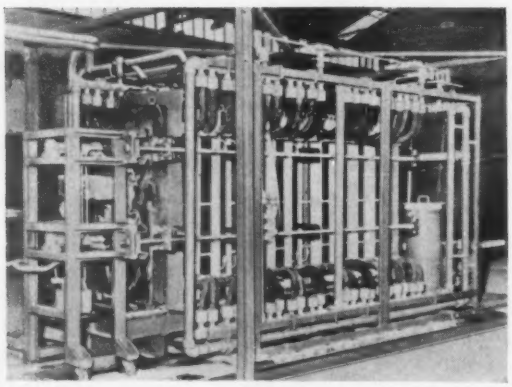
2 • Standard computer system is packaged for off-the-shelf sale to electric-power-generating stations. That is, the system needs minimum special programing to adapt to any steam station, reducing installation time to less than a month. System comprises a central computer with 24,000-word drum memory expandable to 52,000 words and a build-in calculating and checking program. Price of a minimum GARDE system to monitor and log is in the neighborhood of $200,000; delivery time: ten months.—General Electric Co, Industrial Control Dept

Miniature ball valve is versatile, easy to repair

3 • Miniature ball valve is suited to critical control of fluid flow—valve handle rotates with little effort and ball is fully supported by Teflon seat rings. Valve can replace faucets, pet and bib cocks, plug and needle valves for rapid and leakfree operation regardless of pressure and periods of idleness, maker claims. Units mount in panels without needing special adapters. Union-nut end connection takes variety of pieces and lets you remove body from line without disturbing piping.—Valve & Fitting Div, Cooper Alloy Corporation



Water-conversion process recirculates the concentrate



4 • Brackish water is converted to fresh by an electrodialysis process. Water is fed between two ion-permeable membranes and an electric current flows through the cell. Membranes are thin for greater flexibility. One passes positively charged ions, the other negatively charged ions; ions move through the membranes and concentrate in alternate cells. Liquid in intermediate cells is freed of from 2 to 40% dissolved solids. Dissolved-solid concentrate is drawn off and fed back to alternate cells, reducing the current resistance. According to maker, this also cuts amount of acid needed to acidify the concentrate. System's pressure drop is about 50% of what had been considered normal; this means less electrical energy is needed for pumping. Available units convert from 4000 to over a million gpd.—Aqua-Chem, Inc

information center for new products and materials

Portable balancer—a good *PM* tool

5 • Transistorized balancer is portable for use on location—also sets up as a permanent installation in test stands. Four amplifier and control-unit combinations are available. Unit pictured houses three meters, a filter control, left- and right-plane separation networks and controls, angle-phasing and selector switches. Vibration amplitude at pickup location can be indicated or amount of unbalance can be shown in terms of the correction method used. Angles are shown in one or two planes of correction. Five filter arrangements cover speed increments between 300 and 150,000 cpm. Base cost for balancer, vibration pickup and stroboscopic lamp: $1740.—Gisholt Machine Company

Contactors operate quietly

6 • Contactors are mechanically held in open or closed position; they don't hum and are not affected by line fluctuations, manufacturer claims. Molded-epoxy cell resists moisture and keeps the insulation from deteriorating. Low inrush currents to coil give greater flexibility for electrical-system design. Control circuits can be longer and more contactors can be put on one line. Because they handle less inrush current, devices have a longer service life. Extended bus bars make for easy installation in panels and switchboards. You can get at parts quickly for inspection and maintenance.

Mechanically held contactors are available in 30-, 75- and 100-amp sizes and are rated to 600-v ac line voltage on noninductive loads; maximum lighting load is 277 v. —Zenith Electric Company

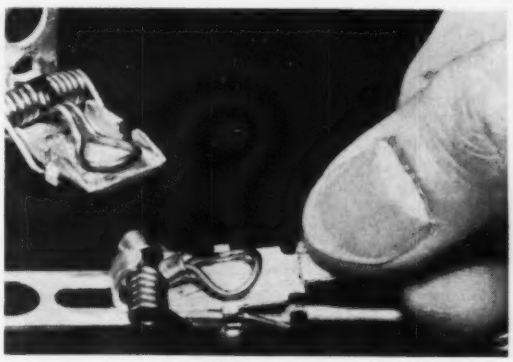
Gearmotor guaranteed not to burn out

7 • Gearmotor for materials handling also replaces air, hydraulic or steam cylinders and produces linear motion. Manufacturer guarantees package won't burn out for one year—electric motor's protective elements are connected in a warning system which removes motor from power source when temperature goes too high. High-torque and-slip intermittent-rated motor has an oversized magnetic disk brake. Crank on the output shaft is machined to receive cams which in turn actuate limit switches mounted on upper part of gear housing. Adjust cams and limit switches and crank pin stops at any position around-the-clock.

Manual-pushbutton or automatic-timing controls are used for starting. Unit accelerates and brakes quickly so connected thrust rod can perform a variety of functions. —Westinghouse Electric Corporation

Terminal assemblies come in two designs

8 • Quick-disconnect brush-terminal-assembly clip is straight, its counterpart has a 90-deg bend. With new straight design two spade terminals can be inserted in one clip, so extra clips aren't needed in some installations. For minimum electrical resistance, clips are made of silver-plated beryllium copper and spade terminals of silver-plated copper. Assemblies can carry a continuous current of 150 amp. Brush replacement is easier, and this design eliminates hazard of dropping tools on the commutator when brushes are changed with machine running.—National Carbon Co

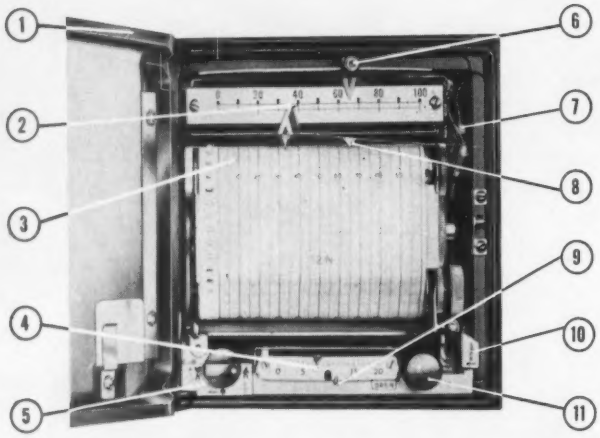


For more data on these developments, circle key numbers on Reader Service card, p 107

ROCKWELL-REPUBLIC

ST-4 Process Control Center groups control station, controller, and recorder in one space saving* assembly

*Requires only 7" x 7-1/8" panel space



1 Die-cast door with clear plastic insert, weatherproof gasket.

2 Secondary variable indication.

3 Full 4" recording width, rectilinear coordinates. Chart is easy to replace.

4 Continuous valve position indicator.

5 Control station (man/auto, man/cascade, man/auto/cascade). Single-case cascade controller provides "bumpless" transfer without a seal position.

6 Set point control and indicator.

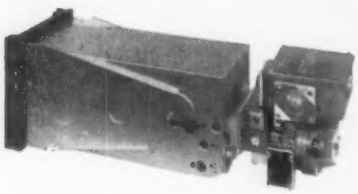
7 Trouble-free sealed cartridge type inking system, refill from front.

8 One, two, or three pen recording.

9 Manual transfer indicator.

10 Chassis lock. Chassis easily removed from front of case. Removal does not interrupt control functions.

11 Manual regulator—separate unit.



Controller may be receiver mounted (as shown) or field mounted.

For more information about the ST-4 Unified Process Control Center and other Rockwell-Republic instruments and controls just mail the coupon.

REPUBLIC INSTRUMENTS AND CONTROLS
more fine products by
ROCKWELL

Please send latest literature on the following:

☐ ST-4 Process Controller ☐ Process Transmitters ☐ Controllers
☐ MP-12 Analogger ☐ Control Stations ☐ Control Valves
☐ VRC Ratio Computer ☐ Drive Units ☐ V-5 Gauges
☐ Desuperheating & Pressure Reducing Systems ☐ Flow Meters
☐ Electronic Control Systems ☐ Pneumatic Control Systems

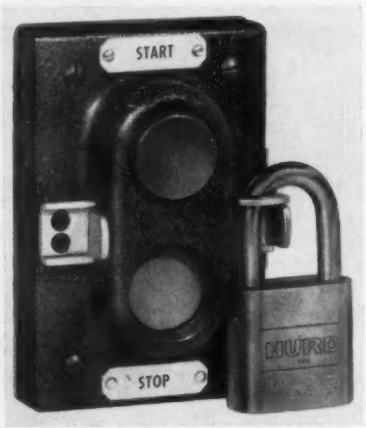
Name_____ Title_____
Company_____
Address_____
City_____ Zone_____ State_____

Republic Flow Meters Co. *(Subsidiary of Rockwell Manufacturing Company)*
2240 Diversey Parkway, Chicago 47, Illinois

RF-26

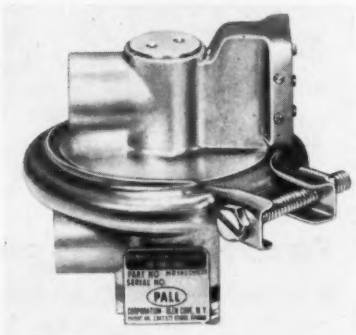
For more facts circle 272 on Reader Service card, p 107

Equipment news



You can padlock these pushbutton switches

37 • Designed for low-cost stop-lockout protection, electrical switches feature sliding latches that you can padlock. Use them on conveyor systems, automation lines, machine tools —with multiple motor drives or where controls are isolated from drives. Maintenance man stops any one motor. Then, once he has padlocked the latch to keep the control circuit open, he can make equipment repairs in safety. — Mackworth G Rees, Inc



Lightweight switches won't leak

39 • Pressure and differential-pressure switches now handle up to 250 psi with no damage or leakage. Pressure acts on a spring-biased diaphragm. A magnet, mounted on the diaphragm, transmits motion to the actuating mechanism through a metal wall, thereby avoiding sealing problems and isolating the electrical mech-

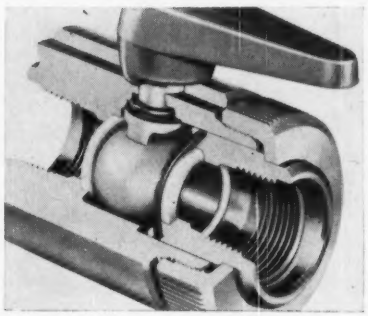
Begins on page 122

anism from the fluid. Switches cover an actuation range from 0.125- to 16-psi differential.—Pall Corporation

Globe valves are redesigned: nonrising wheel, fixed disk

30 • Globe-valve redesign promises closer throttling control and an end to disk vibration and chatter. These valves feature a nonrotating stem with nonrising handwheel and fixed disk. Galling between stem foot and disk is eliminated and, since the stem doesn't turn in its packing, there's no chance for it to spiral through and cause excess leakage. So far, the new design is available in firm's 150-lb corrosion-resistant globe, angle and Y valves, in 2-in. sizes and up.—Alloy Steel Products Co

Just circle key numbers on the Reader Service card page 107, to get complete product story



Ball valve is easy to operate

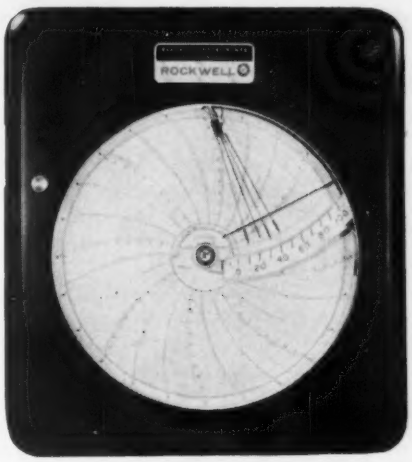
58 • Low-torque PVC ball valve is corrosion resistant and requires only a turn to operate. Available in sizes from ¼ to 4 in. in socket-weld or threaded ends, valve features external 1-end adjustment.—Walworth Company

Valve positioner

33 • This positioner works with diaphragm- or piston-operated control valves and all types of pneumatic drives. According to its maker, it can produce full valve travel in less than two sec. Pilot's long-stroke valve proportions for steady-state stability. A

ROCKWELL-REPUBLIC

MP-12 Analogger combines continuous integrator with 3-15 psig square root extracting receiver



Rockwell-Republic's MP-12 Analogger is a one-to-four pen, 12" circular chart pneumatic receiver recorder. It offers a 3–15 psig square root extracting receiver and a continuous integrator, making it ideal for flow measurement.

The receiver converts a 3–15 psig differential pressure signal to a linear flow record. The integrator, based on Rockwell-Republic's time-proven watt-hour meter principle, catches swings and integrates all of the flow to provide an up-to-the-moment total.

INTERCHANGEABLE PLUG-IN RECEIVERS

The MP-12 Analogger's quadrant design permits a wide variety of recording and integrating combinations to meet your exact needs. For example, up to four completely unitized plug-in receivers may be quickly and easily installed for recording process variables. Or, Rockwell-Republic continuous integrators may be employed in either or both of the upper quadrants.

LIGHTWEIGHT AND COMPACT

Every aspect of the MP-12 Analogger's design from its aluminum case to its compact (requires only 15⅜" x 17⅜" of panel area) construction makes for efficient panel utilization. All connections are at the rear of the case.

ACCURATE CALIBRATION

The MP-12 Analogger's basic receivers are factory calibrated to within ±0.5% of chart range span. All adjustment points require only a screwdriver to make receiver output settings.

For more information about the MP-12 Analogger and other Rockwell-Republic instruments and controls, just mail the coupon. RF-27

REPUBLIC INSTRUMENTS AND CONTROLS
more fine products by ROCKWELL

Please send latest literature on the following:

☐ MP-12 Analogger ☐ Process Transmitters ☐ Controllers
☐ VRC Ratio Computer ☐ Control Stations ☐ Recorders
☐ Control Valves ☐ Drive Units ☐ V-5 Gauges
☐ Desuperheating & Pressure Reducing Systems ☐ Flow Meters
☐ Electronic Control Systems ☐ Pneumatic Control Systems

Name_____ Title_____
Company_____
Address_____
City_____ Zone_____ State_____

Republic Flow Meters Co. *(Subsidiary of Rockwell Manufacturing Company)*
2240 Diversey Parkway, Chicago 47, Illinois

For more facts circle 273 on Reader Service card, p 107

With Alkaserts®...
CONDENSER TUBES LAST LONGER!

■ Low cost ALKASERTS lick the problem of inlet end erosion and impingement. These polyethylene inserts *push-fit easily and securely* into inlet ends of new or old condenser tubes. No adhesive is needed to install. ALKASERTS are flexible, dimensionally stable at 70°C. (158°F.).

■ For new tubes, use "Standard" ALKASERTS . . . streamlined to prevent water flow restriction. Snug fit—no danger of water seepage between tube and ALKASERT.

■ To get maximum life from old tubes, use "Expanded" ALKASERTS . . . made in graduated sizes to match wear pattern found in normal installations.

■ For the complete story on ALKASERTS, write for new Bulletin 600.

TENNANT DEVELOPMENT CORPORATION
100 Park Ave., New York 17, N. Y.

circle 274 on Reader Service card, p 107

Babbitt
Adjustable SPROCKET RIM
with Chain Guide
Changes that Danger Zone to a
SAFETY ZONE

—saves you money
ON EVERY VALVE

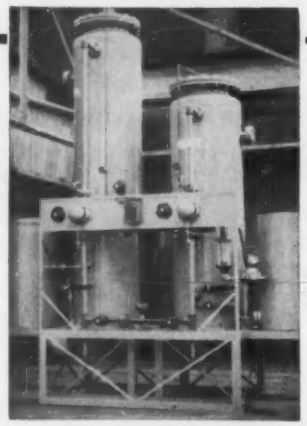
Every minute saved is money in your pocket. Cut out the waste of time, labor, floor space due to hard-to-reach valves. At the same time, convert Danger Zones to Safety Zones. Equip every overhead valve in your plant with Babbitt Adjustable Sprocket Rims with Chain Guides for day to day economy

- They simplify pipe layout.
- They fit any size valve wheel.
- They are easy to install and operate.
- They operate any valve from the floor.
- They save time and money.
- The first cost is the only cost (no maintenance).
- They are packed completely assembled (one to a carton), with easy-to-follow instructions.
- A hot-galvanized rust proof chain is available for all sizes.

Babbitt Adjustable Sprocket Rims with Chain Guide are carried in stock by most mill supply houses. Just phone your mill supply salesman, or contact us

Babbitt STEAM SPECIALTY CO.
2 Babbitt Square, New Bedford, Mass., U.S.A.

circle 275 on Reader Service card, p 107



NEW FROM H&T
Low-Cost • High-Performance
"PACKAGE" DEMINERALIZERS!
TWO-BED and UN-A-BED
STANDARD UNITS
NOW AVAILABLE!!

Unless *special* conditions require you to use a *special* demineralizing system, you can save big money—and get excellent results—with the new H&T Standard "PACKAGE" DEMINERALIZER! Into these superior Standard Units, we've put the experience of 16 years in building many hundreds of manual and automatic demineralizing systems. *Result:* H&T "PACKAGE" DEMINERALIZERS are masterpieces of design and construction—unequalled in performance and wonderfully low in cost.

Write for details of Two-Bed and Un-A-Bed Demineralizers

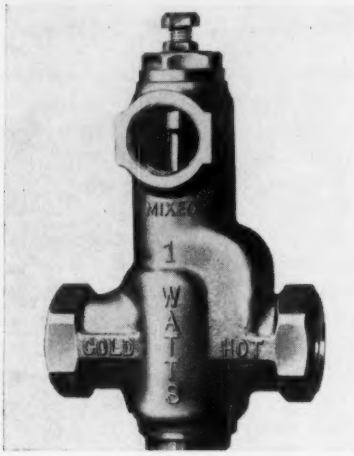
HUNGERFORD & TERRY, INC.
CLAYTON 3, NEW JERSEY

For more facts circle 276 on Reader Service card, p 107

Equipment news

Begins on page 122

feedback rebalances the positioner to jibe with changing load. — Copes-Vulcan Div, Blaw-Knox Company



Water-tempering valves

32 • Designed for large hot-water supply systems, series 170 features bronze bodies, streamlined waterways and high capacity. The 1-in. size passes 31 gpm with a 10-lb pressure drop; the 1½-incher passes 44 gpm. Thermostatic elements interchange in all five sizes, to cut your spare-parts inventory.—Watts Regulator Company

Just circle key numbers on the Reader Service card, page 107, to get complete product story

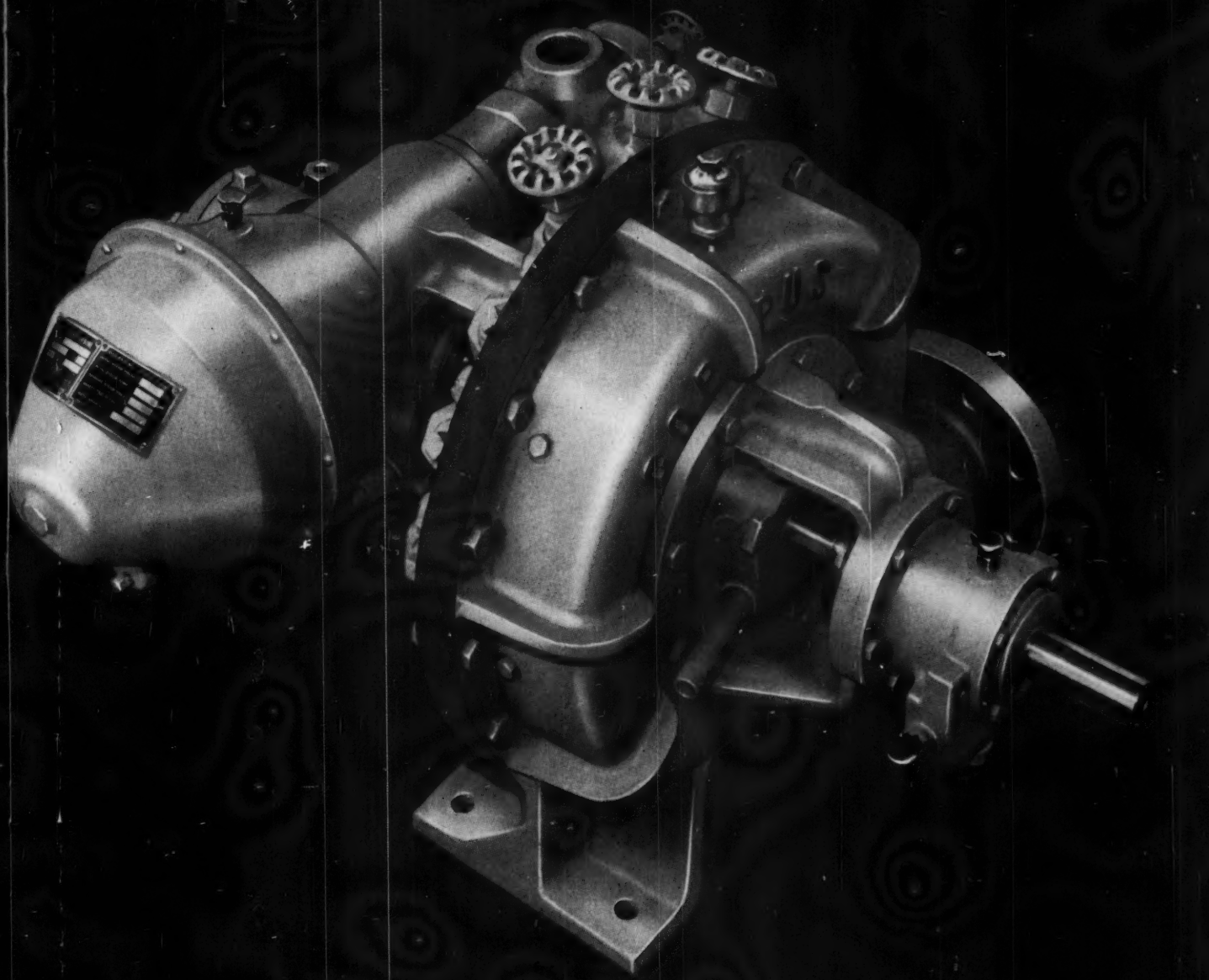
Temperature probe

35 • Concentric shields surround a thermocouple element inside a ¼-in. protective tube with inlet and outlet slots. Use these probes to measure gas temperatures over 1000 F at velocities over 300 ft per sec, where limited space won't let you install larger, shielded probes.—United Sensor & Control Corp

High-accuracy transducer

34 • This accurate and rugged wide-band Hall-effect power computer (transducer) meters, records or monitors power. You can use it as a demand indicator or feedback control. Operating without moving parts, PC-

COPPUS BLUE RIBBON PRODUCTS



Coppus Horizontal Steam Turbine

NEW RUGGED DESIGN—BLUE RIBBON RELIABILITY! Here's a new dimension in turbine performance! Coppus brings you a new rugged stability of design . . . a new measure of reliability in a complete range of power-packed turbines, from 1 HP to 250 HP — marked with the Blue Ribbon only after each is precision made . . . precision tested. Performance features like these assure you Blue Ribbon Reliability —

A totally enclosed governor . . . totally enclosed, independently operated safety trip . . . easily replaceable packing and bearings . . . multiple steam nozzle control . . . brake rim for added safety . . . wide bucket "L" type wheel (optional) for minimum water rate.

Coppus Turbines are built to customers' specifications, including API and NEMA standards. All Coppus Products carry the same Blue Ribbon assurance of reliable performance. For further facts on turbines, send for new Catalog 200. COPPUS ENGINEERING CORPORATION, 168 Park Avenue, Worcester, Mass. Sales Offices in *Thomas' Register*.

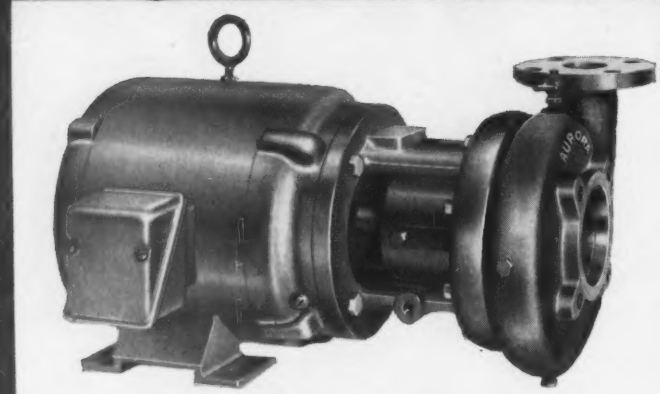
COPPUS
STEAM TURBINES

For more facts circle 277 on Reader Service card, p 107

NEW!

AURORA® TYPE GBH

HIGH EFFICIENCY, LOW HORSEPOWER CLOSE-COUPLED END SUCTION PUMPS



Capacities to 1600 GPM, heads to 330 feet

Especially designed to provide high efficiency and practical economy, the new Aurora Type GBH pumps are suitable for a wide range of services handling hot or cold liquids. Outstanding features include: Completely interchangeable mechanical seal or packing inserts, permitting fast economical conversion for changed conditions ■ Carefully balanced cast impellers that are keyed and locked in position ■ Shaft sleeve construction with "O" ring seal, providing positive sealing, prevention of corrosion, and extension of seal or packing life ■ Extra-length casing rings to provide positive seal, minimize leakage losses, and lower maintenance costs ■ Balancing rings, on pumps with 2″ and larger discharge, to reduce thrust load on bearings and extend pump life ■ Standard NEMA pump motors.

Optional features further increase the economy and versatility of the Type GBH Pump . . . Impeller rings make it easy and inexpensive to extend impeller life and water jacketed inserts provide for handling hot liquids to 250°F. Find out now how these pumps can serve your needs efficiently and economically.

Ask Now For Free Bulletin #108

AURORA Always PUMPS

AURORA PUMP DIVISION

THE NEW YORK AIR BRAKE COMPANY

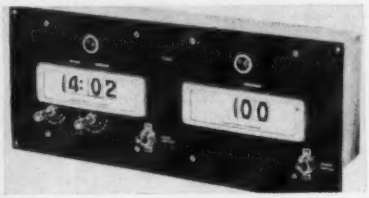
1000 LOUCKS • AURORA, ILLINOIS

LOCAL DISTRIBUTOR IS LISTED IN THE YELLOW PAGES OF YOUR PHONE BOOK

Equipment news

Begins on page 122

500 produces dc-voltage output proportional to true power. Frequency range: from 50 to over 1000 cps.— Ohio Semiconductors



Digital clock provides split second-to-second timing

40 • This new 5-digit-readout clock promises precision timing. There are five drums, for 1 hr, 10 min, 1 min and two to count the seconds. Easy-to-read digits are 5/8-in. high on the 12-hr clock and 5/16-in. on the 24-hr clock. — Pennwood Numechron Co, Electronic Timing Div

Just circle key numbers on the Reader Service card, page 107, to get complete product story

Multirange recorder

38 • Fast 16-point recorder uses four groups of four points. Range change is automatic from one group to the next, in these ranges: 1-, 2-, 5-, 10-, 20-, 50-mv dc. Each group of four points prints in a different color.— The Indikon Company

Magnetic crack-detector probe weighs 14 lb

59 • Portable NDT detector for cracks in ferrous metals is a U-shaped 2-pole electromagnet. It's energized by a 6- or 12-v automobile storage battery or a 110-v service outlet (in

ANOTHER ACHIEVEMENT IN MODERN FLOW CONTROL BY CRANE

CRANE PRESSURE-SEAL BONNET GATE VALVES

are built to meet the toughest demands of high pressure/temperature steam and power piping systems. Special metals—silver, stainless steel, chrome and Stellite* guard all critical valve areas:

1 chrome-plated retaining ring remains freeze-free for easy dismantling; 2 precision tapered silver-plated seal ring eliminates bonnet joint leakage; 3 stainless steel inlay in body insures tight sealing, maximum protection against corrosion; 4 Stellite-faced seating surface and seat rings are engineered for trouble-free, minimum-maintenance service.

Crane Pressure-Seal Bonnet Gate Valves are armored with special metals and careful engineering details. Full travel disc guiding prevents wear and drag on seating surfaces. Flexible wedge disc won't stick even when the valve is closed hot and opened cold. Valve yoke is mounted to the body, transmitting operating torque directly to the valve. The smooth flowing contour design allows straight-through flow with no turbulence.

These gates are your best bet for long, safe, dependable service.

Sizes 1" to 24"; 600-, 900-, 1500- and 2500-pound classes

*Stellite is a registered trademark of Union Carbide Corp.

All Crane Pressure-Seal Bonnet Valves are ASA-rated. Minimum metal thicknesses comply fully with the requirements of ASA B16.5–1957, the ASA Code for Pressure Piping and the ASME Boiler and Pressure Vessel Code.

at the heart of home and industry

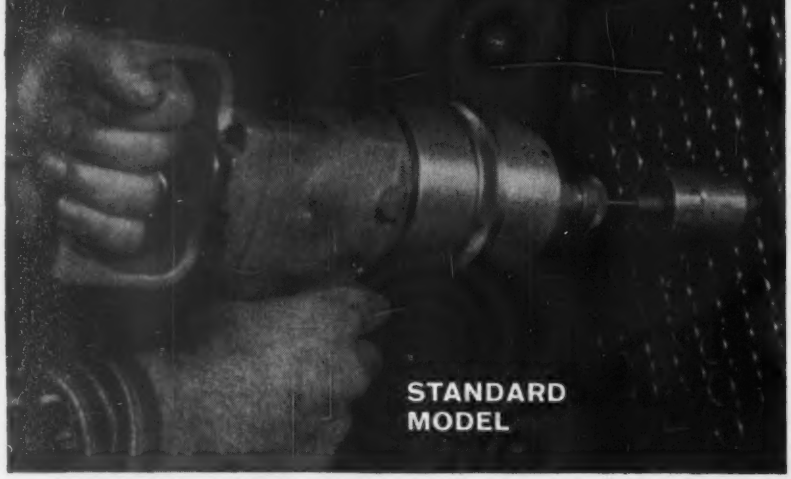
CRANE

valves
piping • electronic controls
plumbing and heating
air conditioning

Crane Co., Industrial Products Group. 4100 So. Kedzie Ave., Chicago 32, Ill. In Canada, Crane, Ltd., 1170 Beaver Hall Square, Montreal.

ELLIOTT air magnetic tube expander drives

automatically controlled for fast, accurate tube rolling



Designed for faster, precision tube rolling, the standard model Elliott Air-Magnetic drive is setting new records for speed and accuracy. Some operators average 12 tubes per minute. Desired torque easily preset by rotating forward end of unit. No tools needed. Rolling stops when preset torque levels are reached. Includes trigger-controlled, explosion-proof air motor in single unit. Magnetic control, no springs. Balanced for easy handling. For tubes ¼ in. through 3 in. *Standard model* handles most jobs. *Heavy-duty* for higher torque.

ALSO Tube Expanders and Related Accessories

Elliott offers a complete line of tube expanders, with rotating, parallel, self-feeding rolls. Available in 4 types, ranging from ¼ in. to 3½ in. O.D. Also the Automatic Electric Control—an accurate torque-limiting device designed for tube expanding with any standard tapping motor.

Elliott Tube Gage

WRITE for Bulletin Y-53

Y1-2

ELLIOTT COMPANY

GENERAL OFFICES: JEANNETTE, PENNSYLVANIA

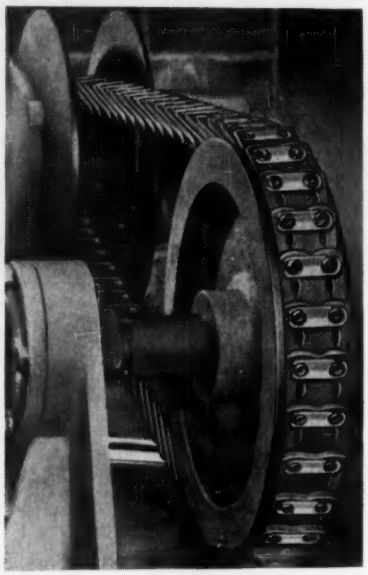
PLANTS AT: Jeannette and Ridgway, Pa.; Springfield, Ohio; Newark, N. J.

TURBINES • GENERATORS • MOTORS • COMPRESSORS • TURBOCHARGERS

DEAERATING HEATERS • EJECTORS • CONDENSERS • STRAINERS • TUBE CLEANERS

this case, through a built-in rectifier). Operator coats the area he wants to examine with a ferromagnetic powder, then places the detector so its two poles bridge the area. A discontinuity in the metal alters the magnetic flux patterns in the powder, showing nature and extent of the flaw.

Operators need little training, maker states. Probe weighs 14 lb; overall weight of set: 30 lb.—Westinghouse Electric Corporation, X-Ray Dept



Variable-speed belting comes as links

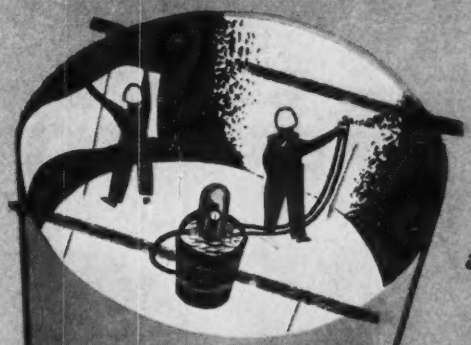
22 • Link belting is easily adjusted to any length; it flexes to fit small-diameter pulleys. You can interchange it with any endless molded or wood-block belt on all V-to-V drives, maker states. Buy it by the foot in single or twin links, widths from ⅞ to 4 in. Install it with pliers and a hook tool. —Lovejoy Flexible Coupling Co

Just circle key numbers on the Reader Service card, page 107, to get complete product story

Thermoelectric generator puts out eight watts

21 • Powered by natural gas, propane or butane, this unit shoots for duties operating valves on gas-trans-

NOW POSITIVE CORROSION PROTECTION FOR THE INTERIOR OF BRICK, STEEL AND CONCRETE CHIMNEYS



Only material proved effective against acids formed by Sulfur Dioxide and Sulfur Trioxide.

foster® STACKFAS®

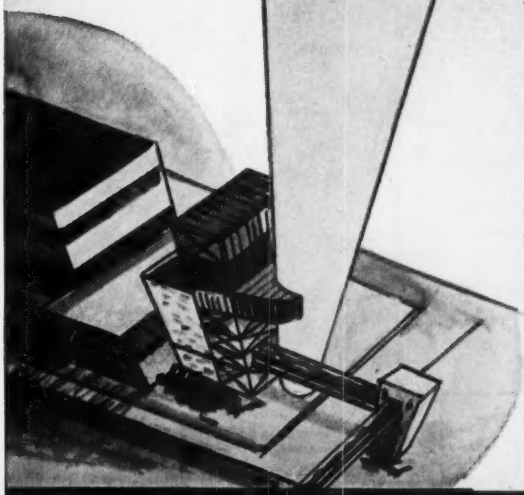
In recent years the cost of new chimney construction and maintenance has skyrocketed due to greater use of more economical low cost coal, heavy fuel oil, refinery sludge and sour gases which form stronger acids resulting from the use of these high sulfur fuels. The lowering of the gas temperatures through the use of economizers has increased the problem. Heretofore no coating has succeeded in resisting these highly corrosive acid gases.

Now, after two years of intensive research and testing, Benjamin Foster Company releases STACKFAS—the world's first exclusive corrosion resistant material proved effective against high sulfur chimney gases.

Foster STACKFAS has been field tested and proved by twenty-four major public utilities, chemical and industrial plants. Its development program had the cooperation of the nation's most renowned consulting engineers, insulation manufacturers and chimney constructors.

Rarely has a product been subjected to such wide study and testing. This cooperation was made possible because it was apparent from the outset that Foster STACKFAS would make obsolete all previous specifications and recommendations for the protection of chimneys and stacks against corrosive flue gases.

For complete details, specifications and applications of Foster STACKFAS, write for Bulletin No. SF-61.



foster COATINGS · SEALERS · ADHESIVES

BENJAMIN foster CO.
4635 W. GIRARD AVE. • PHILA. 31, PA.
Division of Amchem Products, Inc.

BENJAMIN foster CO. 4635 W. GIRARD AVE. • PHILA. 31, PA.

Please send me Bulletin SF-61. I understand there is no obligation.

Name_____

Company_____ Title_____

Street Address_____

City_____ Zone_____ State_____

For more facts circle 281 on Reader Service card, p 107

YOU CAN USE THIS!

BECAUSE PRICE IS IMPORTANT.
DON'T PAY FOR MORE THAN YOU NEED,
BUT DON'T PAY MORE AND GET LESS.
THE B&J TYPE GW STEAM TRAP GIVES YOU CONSTRUCTION AND PERFORMANCE FAR IN EXCESS OF ANY TRAP PRICED SO LOW.

- Discharges more condensate faster.
- Discharges more air faster.
- Operates with absolute uniformity.
- Priced with the lowest yet all working parts are monel and stainless steel.
- Only trap with factory assembled, calibrated and pre-tested replacement interior.
- There is a B&J thermostatic steam trap for almost every trapping job: pressures from vacuum to 300 PSIG, capacities to 25,000 lbs. per hour. Pipe sizes ½" to 2". Bronze, semi-steel, cast steel.

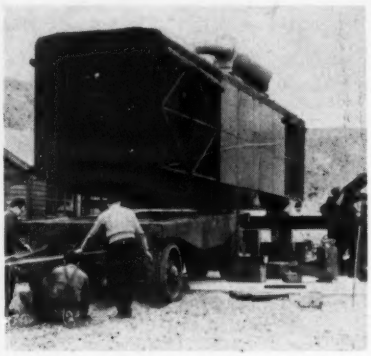
Don't take our word for it. Try a B & J steam trap for 30 days at our expense. Just tell us your capacity and pressure needs.

BARNES & JONES, INC.
34 Crafts St. • Newtonville 60, Massachusetts

Equipment news

Begins on page 122

mission lines and cathodically protecting submerged metal. The 8-w generator measures 12 x 17 in., tips the scales at 65 lb. Other power ranges will be available later.—Texas Instruments

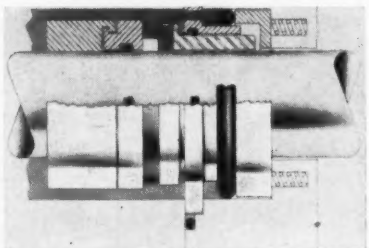


Mobile diesel set offers up to 1500 kw

56 • Powerful diesel set can be rushed by highway to handle peak loads, standby or emergency service. It comes up to full load within 20 sec of demand. Engine combines diesel economy with gas-turbine weights, according to the manufacturer.

Initial 1200-kw set is smaller than a standard semi-trailer. Weight: less than 30 lb per hp complete.—D Napier & Son (Canada) Ltd

Just circle key numbers on the Reader Service card, page 107, to get complete product story

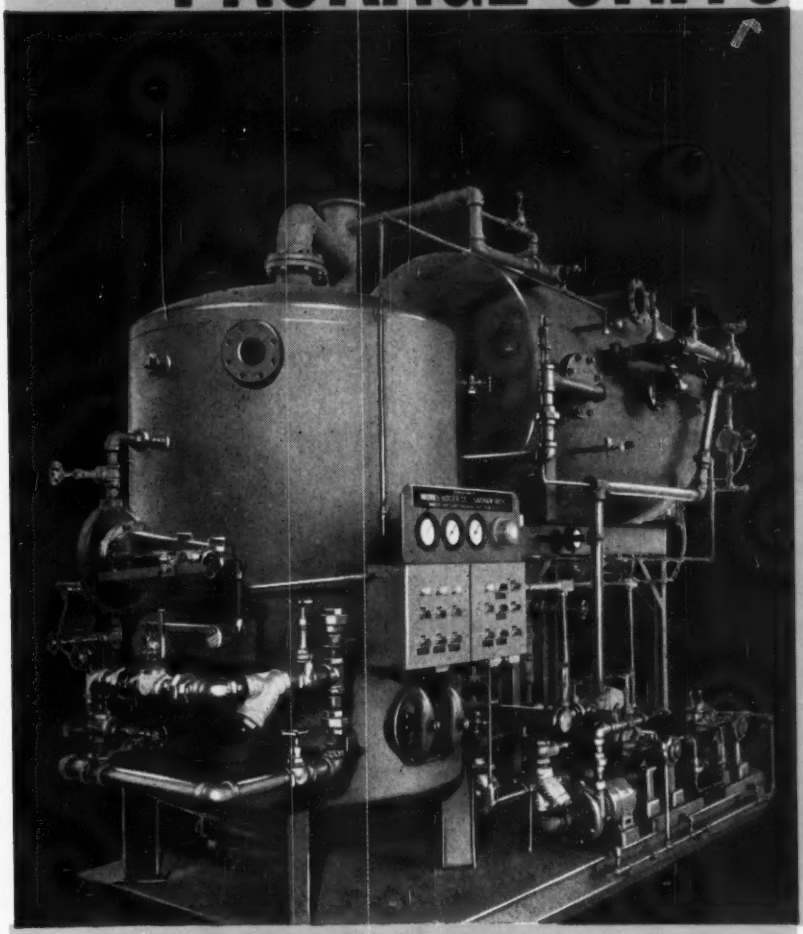


Positive seal works by fluid pressure

24 • Balanced hydraulic pressure replaces operational springs in this seal, for positive closing under varying loads. Springs' only job is to hold faces in sealing contact at fluid pres-

WICKES BOILER AUXILIARY PACKAGE UNITS

standard



Save On First Cost • Engineering • Building Space • Construction Time • Operating and Maintenance Cost

Wickes Boiler Co. now offers a packaged system of various compact combinations of DEAERATING FEED WATER HEATERS, BOILER FEED PUMPS, CONDENSATE SURGE TANKS and BLOW-OFF TANKS. Standard units available for steam plants of 10,000 to 100,000 lbs. of steam per hour capacity and steam pressure to 300 PSIG. Information on special units of higher capacities and pressures upon request. Each unit is shop-assembled on a structural steel base, completely piped and wired and equipped with all necessary controls and an instrument panel.

173

Write today for Bulletin 59-1, which gives detailed engineering information on all three models of Wickes Boiler Auxiliary Package Units.

WICKES BOILER CO., SAGINAW 10, MICHIGAN
Division of The Wickes Corporation

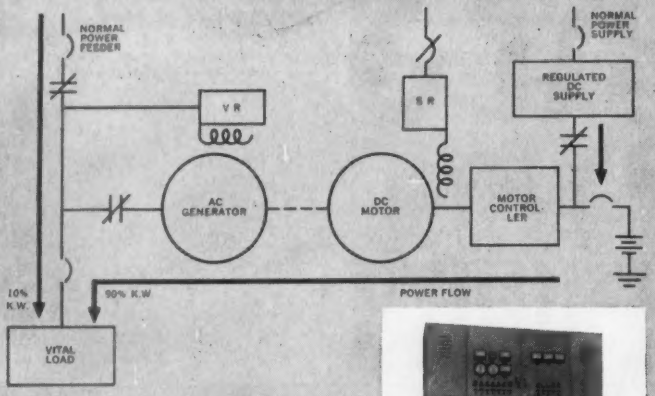
WICKES

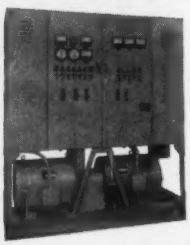
RECOGNIZED QUALITY SINCE 1854

SALES OFFICES: Atlanta • Boston • Charlotte, N. C. • Chicago • Cleveland • Dallas • Denver • Detroit • Houston • Indianapolis • Los Angeles • Memphis • Milwaukee • New Orleans • New York City • Philadelphia • Portland, Ore. • Rochester, N. Y. • Saginaw • San Francisco • Seattle, Wash. • Springfield, Ill. • Tulsa

For more facts circle 283 on Reader Service card, p 107

AN AMMONIA PLANT APPLICATION...





In the installation pictured, the rating of the AC generator is 12 KW, .8 power factor, 1 phase, 60 cycle, 460 volt.

ANOTHER EXAMPLE OF HOW KEARFOTT ASSURES CONTINUOUS, UNVARYING POWER FOR CONTROL EQUIPMENT AND INSTRUMENTATION

The heavy losses which can occur when power interruptions or fluctuations affect the control equipment and instrumentation in manufacturing processes, are effectively prevented by Kearfott Uninterrupted Power Systems. The system described below, used in an ammonia plant, is typical of many now in use, all with a perfect record for reliability.

In this particular system, a DC motor drives an AC generator, the output of which is the same as the normal available power. Meanwhile, the DC power that runs the motor also keeps the batteries in fully charged condition. When failure of the prime power occurs, the motor continues to run on the batteries, and the AC generator continues to meet the vital power load requirement. Controls and instrumentation continue without interruption. Voltage and frequency are regulated to within ±1% of rated values, regardless of variations in normal power supply input.

Kearfott's compact uninterrupted power equipment combinations are also available in 2 and 3 unit systems operating in parallel with or isolated from the line. Provisions may be had for audible and/or visual alarms to indicate over- and under-voltage, overload or ground conditions.

Generator ratings to 150 KVA 60 and 400 cycles, single and polyphase. Frequency, voltage and transfer regulations as required by the application.

Write for complete data

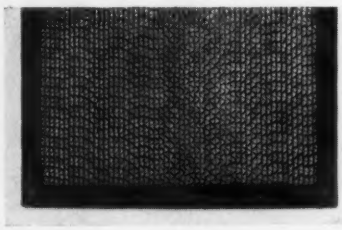
KEARFOTT DIVISION
GENERAL PRECISION, INC.

Little Falls, New Jersey

Equipment news

Begins on page 122

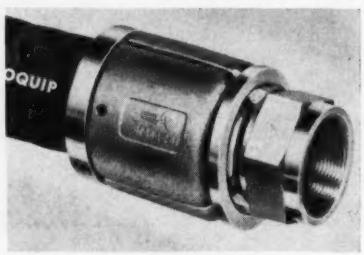
sures below design. Fluid pressures, as they rise, act against the springs. The result is symmetrical and uniform face sealing, according to the manufacturer.—A W Chesterton Co



Disposable filter removes odors

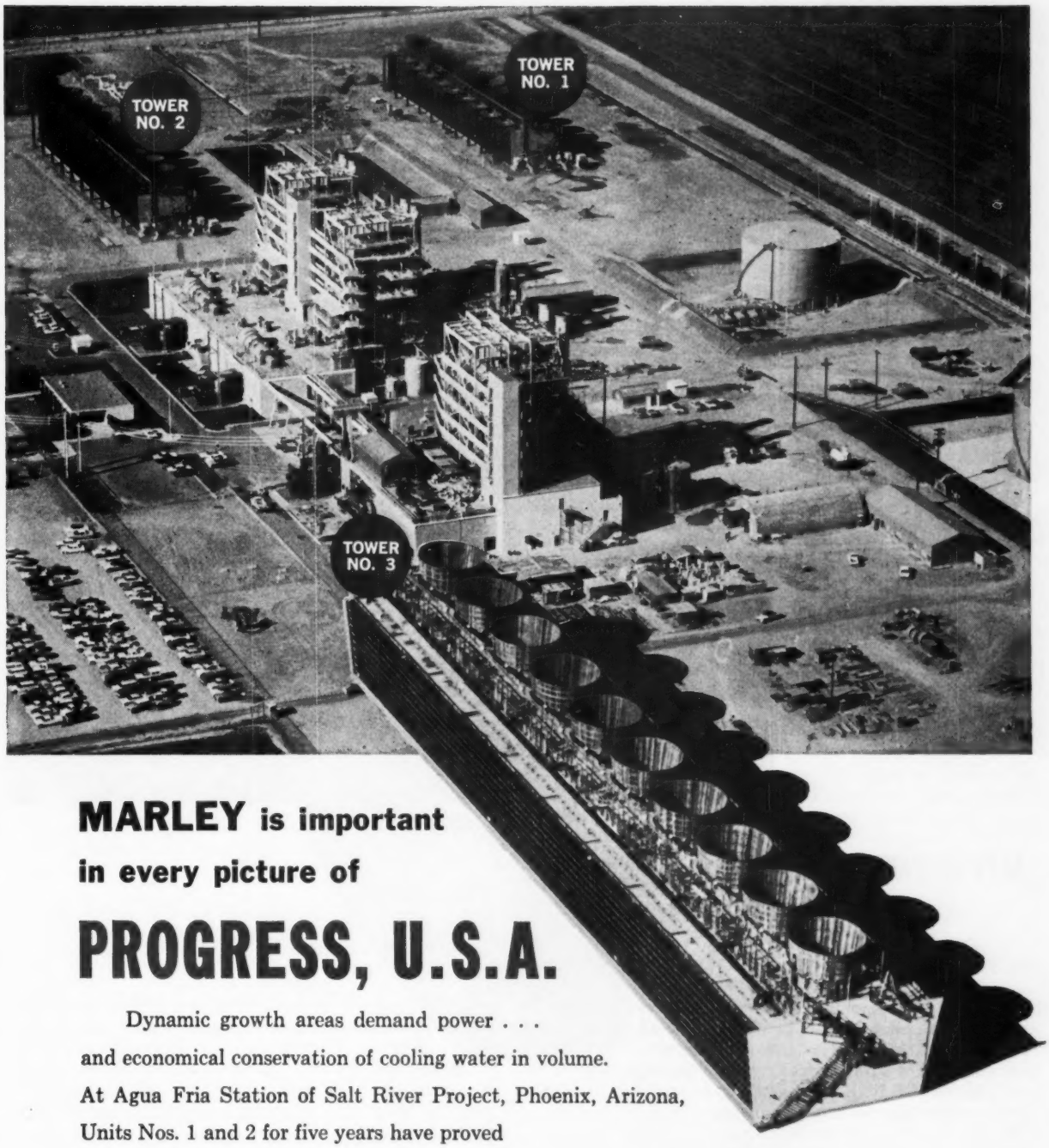
27 • An economical answer to most odor problems, activated-charcoal-coated fiber strips assemble in disposable but sturdy paperboard frame. The lightweight filters, available in standard sizes with or without dust media, handle duty in forced-air ventilating systems. Low resistance to air runs 0.04 at 300 fpm.—Barnebey-Cheney Company

Just circle key numbers on the Reader Service card, page 107, to get complete product story



Spiral-wrap hose works up to 3000 psi

29 • Large-diameter hose—1¼ to 2 in.—is designed for hydraulic systems under pressures up to 3000 psi. Inner tube alternates layers of spiral wire wrapping and synthetic rubber. Segmented fittings, leak- and blowoff-proof, assemble quickly with hand tools.—Aeroquip Corporation



MARLEY is important in every picture of

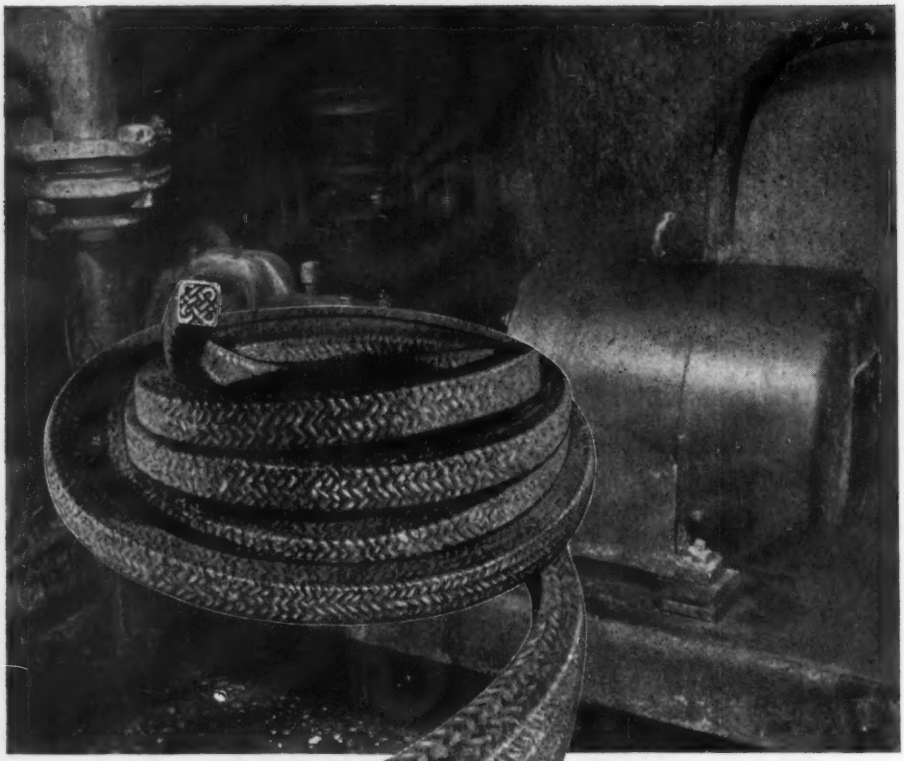
PROGRESS, U.S.A.

Dynamic growth areas demand power . . . and economical conservation of cooling water in volume. At Agua Fria Station of Salt River Project, Phoenix, Arizona, Units Nos. 1 and 2 for five years have proved the practicality of big per cell capacity cooling towers teamed with big capacity turbines. A Marley Class 600 Double-Flow was recently supplied to furnish condensing water for the 168-mw Unit No. 3. It is the largest machine served by a single-structure cooling tower and, says T. M. Morong, Chief Engineer, "Tests indicate it is contributing to our having a plant that more than meets design criteria." It also contributes economy in required plant area, piping cost and maintenance.

THE MARLEY COMPANY • KANSAS CITY, MISSOURI

For more facts circle 285 on Reader Service card, p 107

Apply Garlock 5875 Teflon-impregnated LATTICE BRAID Packings to centrifugal and rotary pump shafts, valve stems and expansion joints, and reciprocating rods, rams, and plungers . . . a premium packing at regular packing prices.**



**Patent applied for

ENGINEERED TEFLON* PRODUCTS

Exclusive Garlock manufacturing technique creates unique properties in Teflon-impregnated LATTICE BRAID Packings. The use of pre-sintered Teflon powder gives new, low cost Garlock 5875 LATTICE BRAID† Packing greater stability under temperature changes and outstanding resistance to glazing. The pre-sintered Teflon powder on the white asbestos yarn does not absorb water; hence, there is no "wicking" action, and minimum axial swell. The ground particles of Teflon form millions of bearing points on the packing surface . . . effectively reduce friction and wear . . . once installed, retightening or adjustments are rarely, if ever, necessary. Garlock 5875 LATTICE BRAID Packing contains over 30% Teflon by actual weight—affords excellent resistance to moderately destructive and corrosive acids and caustics from −90°F to +500°F.

Costs no more than regular packing. Garlock 5875 LATTICE BRAID Packing sells for almost 40% less than other Teflon packings in use today. At this price, you can enjoy all the new features of 5875 plus the advantages of LATTICE BRAID construction: completely integrated structure for greater strength, longer life, more flexibility and lower maintenance cost. No single outer braid or cover to wear through. Garlock 5875 LATTICE BRAID holds together without disintegrating, wears far beyond ordinary packings.

Enjoy fast delivery from warehouse stock. Garlock 5875 Packing is immediately available in sizes from ¼″ through 1″ in either spool or reel form to meet your specific needs. Call your local Garlock representative at the nearest of the 26 Garlock sales offices and warehouses throughout the U. S. and Canada. Or, write for Catalog AD-185, Garlock Inc., Palmyra, New York.

Canadian Div.: Garlock of Canada Ltd. **Plastics Div.:** United States Gasket Company. **Order from the complete line** of quality Garlock products . . . Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Stock and Parts.

*DuPont Trademark for TFE Fluorocarbon Resin †Registered Trademark

GARLOCK

How Much Steam Should a Steam Trap Trap?

. . . some answers to commonly asked questions about the primary job of a steam trap

You don't need a doctor's degree in thermodynamics to answer the question at the top of this page. Naturally, a steam trap should trap *all* the steam.

Unfortunately for you, the problem isn't quite that simple. After all, a shut off valve would trap all the steam . . . and condensate, and air, and carbon dioxide as well.

So we'd better amend the answer to the question this way: A steam trap should trap *all* the steam but *must* remove condensate, air and carbon dioxide as rapidly as they accumulate.

With this established, let's take a closer look at what's involved:

A Steam Trap Should Trap All The Steam

If you've had experience with several different makes of traps, you already know that some trap steam better than others. The operating principle of the trap is what makes the difference. We like to talk about it because Armstrong traps are designed so that no steam can get to the orifice. The valve is always water sealed. Result: *More efficient steam utilization, lower fuel costs.*

A Steam Trap Should Remove Condensate

All traps remove condensate—after a fashion. For maximum efficiency in the unit being drained, though, the trick is to get it out without waiting for it to cool and without leaking steam.

Armstrong's water sealed valve takes care of steam leakage. The inverted bucket operating principle opens the trap for water regardless of its temperature. This means you get the condensate out as quickly as it accumulates. Result: *Higher temperatures and better heat transfer in steam heated units.*

A Steam Trap Should Remove Air and CO_2

Part and parcel of the condensate removal problem is removal of air as well as oxygen and carbon dioxide—two real troublemakers. Air tends to reduce operating temperatures and interfere with heat transfer. CO_2 goes into solution to form corrosive carbonic acid which, for example, can eat unit heater tubes. O_2 aggravates the situation. Believe it or not, but all traps don't properly remove air and CO_2.

By now, you've probably guessed that Armstrong traps *do* remove air and CO_2. Armstrong design (see illustration) provides continuous venting of air and CO_2. By opening suddenly, the Armstrong trap creates a momentary pressure drop to "pump" the air down to be vented. Result: *Higher temperatures, faster heat-up, better heat transfer and reduced corrosion.*

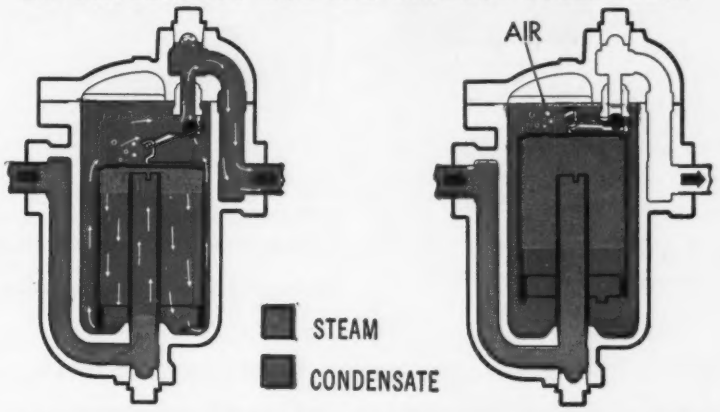
Note: When required, specially sized air vents are furnished. For fast heat-up of low pressure on-and-off units, Armstrong provides open float and thermostatic air vent traps.

What's the Final Answer?

Summing it all up, you'll get the best service from steam heated units that are equipped with traps designed to trap *all* the steam and remove air and condensate as quickly as it accumulates. In our prejudiced viewpoint, this means Armstrong traps. More important are the several thousand users of Armstrong traps who have proved the point.

See our Catalog in Sweet's Plant Engineering File

HERE'S THE STEAM TRAP DESIGN THAT GETS RID OF CONDENSATE AND AIR WITHOUT STEAM LOSS



Trap open. Condensate entering trap has caused bucket to lose buoyancy. Weight of bucket times leverage pulls valve open. Air is discharged along with condensate.

Trap closed. Steam has floated inverted bucket; valve is held tightly closed by system pressure. Air entering trap passes through bucket vent and accumulates at top of trap.

Before you make up your mind, though, consider the minimum maintenance requirements of Armstrong traps . . . and the convenient assistance your local Armstrong Representative provides. These are important plus values.

Put Up or Shut Up

We're so confident that we "put up". Armstrong traps are unconditionally guaranteed to satisfy. So you can find out for yourself with practically no risk. If you're not completely satisfied with the way they do their job, you can get your money back.

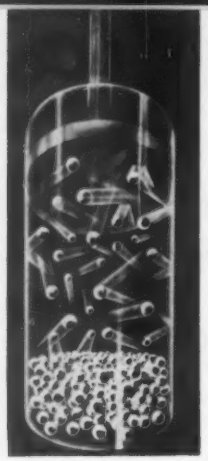
* * *

The 44-page Armstrong Steam Trap book goes into greater detail on these and other Armstrong features. It also discusses trap selection, installation and maintenance. Ask your Armstrong Representative for a copy or write

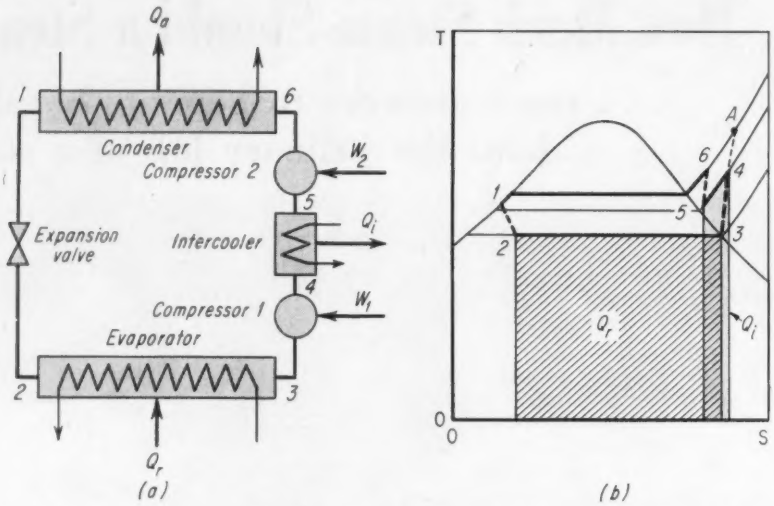
Armstrong Machine Works
8121 Maple Street
Three Rivers, Michigan

ARMSTRONG STEAM TRAPS

For more facts circle 287 on Reader Service card, p 107



THERMO REFRESHER NO. 52



1 Splitting compression of the vapor into two steps and adding intercooling reduces the work input to cycle and improves COP. Gray area in *b* shows heat of intercooling

By B G A SKROTZKI
Associate Editor

Hoisting low-temperature energy to atmospheric levels can be done a number of ways. We can use different refrigerants as well as improved or special cycles

Vapor-cooling cycles take many forms

Energy, being costly, should be used as economically as possible. So we try to run refrigerating cycles at least cost. Studying compressed-air cycles, we learned that by splitting gas compression into steps and using intercooling we can reduce the work input. This same idea fits into the vapor-compression refrigerating cycle to raise the COP.

Simple intercooled cycle, Fig. 1*a*, has two compressors in series with an interposed intercooler. Cooling water carries off some of the internal energy of the compressed vapor leaving the l-p compressor, No. 1. This gives an additional point of energy removal from the closed cycle. Its energy balance is:

$$Q_r + W_1 + W_2 = Q_a + Q_i \qquad (1)$$

$$W_1 + W_2 = Q_a + Q_i - Q_r \qquad (2)$$

Fig. 1*b* shows the T-S graph for this cycle. Temperature at state 5 leaving the intercooler can't be any lower than that of the cooling water entering the intercooler. This limits the advantage of intercooling and may mean that the work of the l-p compressor may be considerably more than that of its counterpart. Equal work in both compressors usually is the most economic division. The graph assumes that each compressor produces an irreversible adiabatic compression of the vapor.

Hatched area measures heat Q_r absorbed by evaporator and gray area measures heat Q_i removed by the intercooler. Area under process *6-1* (not outlined) would measure the heat rejected by the condenser, Q_a. The dotted process line *3-4-A* shows the path for an irreversible single-stage compression between the top and bottom pressures of the cycle, without intercooling. The work saved by intercooling can be *roughly* estimated as area *4-5-6-A*, since:

$$W_1 = H_4 - H_3$$

$$W_2 = H_6 - H_5$$

and the work of single-stage compression is:

$$W_s = H_A - H_3$$

Work saved:

$$= W_s - (W_1 + W_2)$$

$$= H_A - H_3 - (H_4 - H_3 + H_6 - H_5)$$

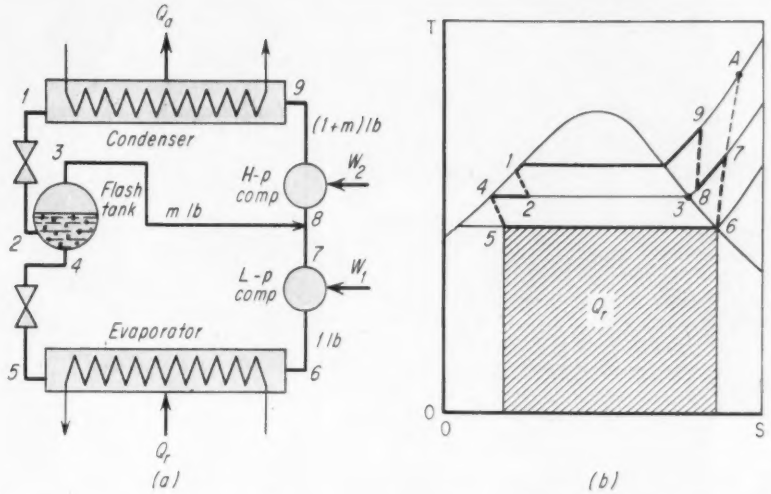
$$= H_A - H_4 + H_5 - H_6 \qquad (3)$$

Regenerative intercooling, Fig. 2, improves on the simple cycle. Relatively high-temperature cooling water is no longer needed to remove Q_i. The cycle has two expansion valves in series, two compressors in series and a flash tank connected between. Adjusting compressors and expansion valves controls pressure of the refrigerant fluid in the flash tank.

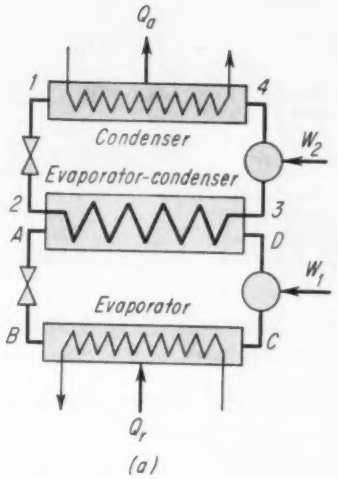
How does the system work? Assume we have 1 lb of vapor leaving the evaporator at state *6;* the l-p compressor pressurizes and superheats it to state *7*. Here m lb of dry saturated vapor from the flash tank at state *3* joins the 1 lb from the l-p compressor.

Mixing the two vapors produces $(1 + m)$ lb of vapor at state *8* (superheat less than at state *7*); that then enters the h-p compressor. Irreversible adiabatic compression pressurizes and superheats the $(1 + m)$ lb of vapor to state *9*. Condenser then removes Q_a from $(1 + m)$ lb of vapor to change it to a subcooled liquid at state *1*.

The $(1 + m)$ lb of liquid then throttles through the h-p expansion



2 Regenerative intercooling of vapor compression has more flexibility than simple intercooling and can be carried out at a lower overall temperature level in cycle



valve to state *2* at the intermediate pressure in the flash tank. One lb of saturated liquid at state *4* throttles through the l-p expansion valve to state *5* to enter the evaporator. At the same time m lb of saturated vapor at state *3* leaves the flash tank to join with 1 lb of superheated vapor at state *7* leaving the l-p compressor. From here the cycle repeats, with the 1 lb of saturated vapor at state *6* leaving the evaporator after having absorbed refrigeration load Q_r.

Since the T-S graph of Fig. 2*b* is drawn for 1 lb of fluid we can directly show Q_r as an area. Processes *8-9-1-2* all have $(1 + m)$ lb of fluid flowing in the cycle, so true Q_a referred to Q_r cannot be shown in proper proportion. But using the same reasoning as in Fig. 1, irreversible adiabatic compression *6-7-A* shows the path for a single compression process between cycle pressure limits. *Roughly*, then, area *7-8-9-A* shows the work input saved by regenerative intercooling.

A variation of intercooling idea uses a single-stage compressor. During compression, however, liquid refrigerant is injected to reduce superheat of the discharged pressurized vapor. Depending on their refrigerant, most compressors have jacket cooling at the h-p end of the cylinder to help reduce final superheat and work input.

Cascade system, Fig. 3, is used where very low temperatures are wanted for refrigeration. Here low-temperature cycle *A-B-C-D* may use one refrigerant to absorb the refrigerating load Q_r. It rejects heat:

$$Q_{a1} = Q_r + W_1$$

to high-temperature cycle *1-2-3-4* in the evaporator-condenser, connecting the two cycles by heat-transfer surface for energy disposal.

In the high-temperature cycle the condenser finally rejects cascade-cycle heat to atmosphere as:

$$Q_a = Q_{a1} + W_2 = Q_r + W_1 + W_2 \qquad (4)$$

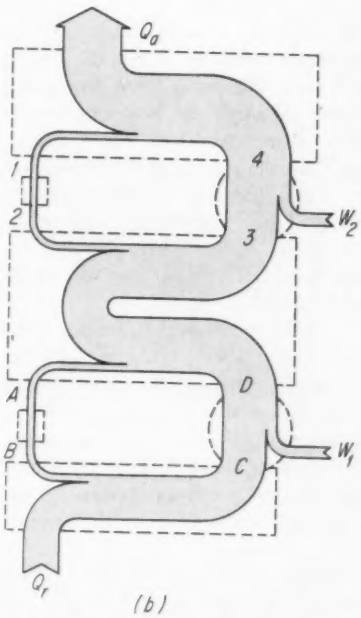
COP in an actual cycle suffers from the additional temperature drop that must be carried in the combined evaporator-condenser.

Fig. 3*b* is the energy-flow diagram for the cascade system. Refrigerants in each cycle would be chosen to gain the best design factors, taking into account specific heats, specific volume, pressure - temperature relation and other properties.

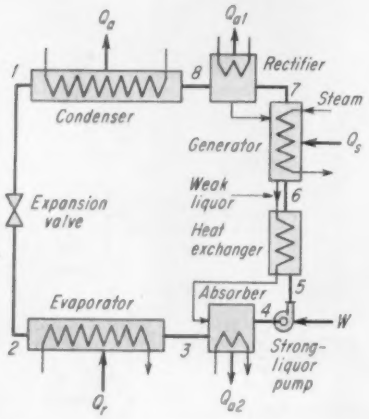
Absorption refrigeration, Fig. 4, uses a system with a different method of raising the refrigerant from the low- to the high-pressure level of the cycle. Processes *8-1-2-3* are the same as in Fig. 1, but in place of a compressor we have four heat exchangers and one liquid pump. Their advantage: they take much less valuable mechanical work input (for the pump), so most of the energy input goes into the generator in the form of heat Q_s.

Saturated ammonia vapor leaving the evaporator enters an absorber filled with water. Ammonia goes into solution with the water at various concentrations. High concentration, called *strong liquor*, rises to the top of the absorber while lighter concentration, *weak liquor*, drops to the bottom.

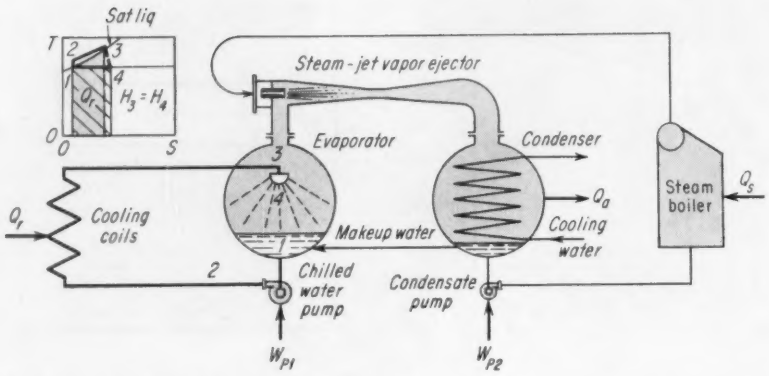
Heat released by the process of dissolving ammonia in the water is car-



3 To develop lower refrigeration temperatures, vapor-compression cycles may be cascaded, each cycle using refrigerant best suited to its temperature range



4 In ammonia-water absorption system, exchangers, pump replace compressor



5 Vacuum refrigeration system develops moderate cooling temperatures, uses water pumps and steam-jet vapor ejector instead of vapor compressors for cycle work input

ried away by cooling water. Cooling the water raises its ability to absorb ammonia. The pump forces the strong liquor through a heat exchanger where it preheats weak liquor returning from the generator to the absorber. From the heat exchanger at *6*, strong liquor enters the generator where the steam coils carrying Q_s heat it and drive the ammonia out of solution with the water.

A mixture of ammonia and water vapor then enters the rectifier. It leaves behind it, in the generator, a weak liquor that returns to the absorber through the heat exchanger. The rectifier further separates water and ammonia vapors, returning the condensed water vapor to the generator for disposal.

Cooling water through the rectifier carries off some of the water's and ammonia's heat of vaporization. Ammonia vapor then enters the condenser to reject heat Q_a. Heat balance of the entire cycle is:

$$Q_r + W + Q_s = Q_a + Q_{a1} + Q_{a2} \quad (5)$$

In many systems, sum of Q_{a1} and Q_{a2} is of the same order as Q_a.

This cycle is most likely to apply where heating steam for the generator is available as a byproduct of some other process.

Vacuum refrigeration, Fig. 5, develops moderately low temperatures, such as used in space air conditioning for comfort. Evaporator develops a supply of chilled saturated water that the chilled-water pump forces through cooling coils to absorb refrigerating load Q_r.

Warmed water returns to the evaporator where it sprays into the evacuated space in a throttling process. In this constant-enthalpy process the warmed, pressurized water evaporates to a very wet vapor at the lower pressure and correspondingly lower temperature held in the evaporator. Drops of liquid fall to the bottom of the evaporator while vapor fills the space above the liquid pool.

Small T-S chart in Fig. 5 shows the processes of the chilled water. *1-2* is the ideal constant-entropy pressurizing in the pump; *2-3* is the constant-pressure warming in the cooling coils by absorption of heat Q_r (gray area); *3-4* is the throttling in the spray head of the evaporator. Process *4-1* shows equivalent constant-pressure cooling needed to remove heat Q_r (hatched area) from the chilled-water circuit.

In the *T-S* graph, total gray area under *2-3* measures Q_r. But since $H_4 = H_3$, the hatched area under *4-1* also measures Q_r. With warmed chilled water returning to the evaporator, an accumulation of dry saturated vapor builds up. To maintain the low pressure, the steam-jet vapor ejector must continuously remove this vapor. Steam from the boiler powers the ejector.

Mixture of evaporator vapor and jet steam discharges into a closed condenser with cooling coils or tubes. Cooling water flowing through the tubes absorbs the heat of vaporization and condenses the mixed vapors by carrying off heat Q_a. Condensate pump returns the jet part of the condensate to the boiler. The small remainder goes back to the evaporator where it replaces vapor withdrawn by the ejector.

Heat balance of the cycle in Fig. 5:

$$Q_r + Q_s + W_{p1} + W_{p2} = Q_a$$

This cycle has the advantage of needing a very small amount of mechanical work input. Steam for the vapor ejector need only be at a moderate pressure and may be available as a byproduct from some other process. Disadvantage lies in the relatively high refrigeration temperature the cycle develops, which limits the range of its usefulness. Let us study an example to understand the factors of this cooling cycle.

Example. A vacuum refrigeration system runs with evaporator temperature of 45 F and chilled water returning at 60 F. Condenser holds a pressure of 1.135 psia and the steam-jet ejectors need 3.1 lb of boiler steam per lb of vapor removed from the evaporator. Find lb of boiler steam needed per ton of refrigeration.

Solution: First, let's refer to the Steam Tables and list needed enthalpies for our calculations.

At 45 F—P = 0.14752 psia; h_f = 13.06 Btu per lb; h_{fg} = 1068.4 Btu per lb

continued

circle 288 on Reader Service card, p 107 ➤

where trouble-free performance is a matter of pride...

SCOVILL®

HEAT EXCHANGER TUBE

HEAT EXCHANGER TUBE for Application from Marine to Petrochemical, from Compressor Intercoolers to "Cat-Cracker" Exchangers, in these popular Alloys . . . Phosphorized Admiralty • Admiralty • Arsenical Admiralty • Red Brass, 85% • Deoxidized Copper • Arsenical Copper • Cupro-Nickel, 10%-20%-30% • Aluminum Brass • Aluminum Bronze, 5% • Muntz Metal • Duplex Tube

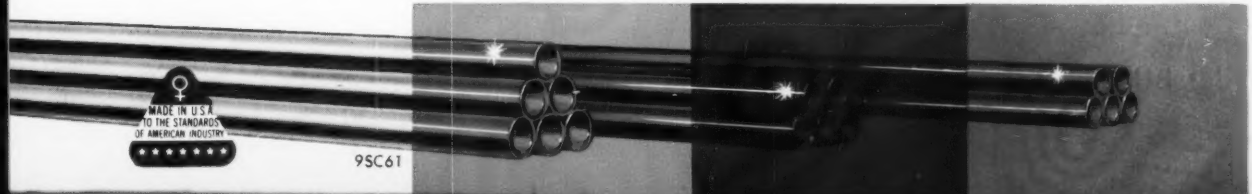
Scovill Heat Exchanger Tubes enjoy a first-choice reputation among outstanding plant operators because of the excellence of Scovill tube alloys . . . their superior uniformity and their close adherence to all specifications through extremely tight quality controls maintained by our tube mills.

The Port Wentworth Station of Savannah Electric & Power Company is a good example. Photographs show installation of tube in the split condensers in the No. 2 Unit at Port Wentworth, using 77,000 lbs. of Scovill Admiralty Heat Exchanger Tube ordered for this job. Cooling water is drawn from the Savannah River and has a salt content varying from 30 to 19,000 ppm. At times it may be contaminated by industrial wastes and sewage. Unit No. 2, placed in operation in May 1961 with a capability of 54,000 kw, doubles the capacity of Port Wentworth.

Draw upon Scovill experience as specialists in heat exchanger tube. It will be worthwhile talking to our technical men if you feel that an improvement in performance may be possible.

SCOVILL MANUFACTURING COMPANY

Mill Products Division • 99 Mill Street, Waterbury, Connecticut • Phone PLaza 4-1171



9SC61

Darling Cast Steel Gate Valves

are made in regular and special compositions to match the exact operating conditions found in high pressure refining, pipeline, power plant, and process industry services.

The revolving double disc parallel seat and wedge construction, with plain "no-pocket" discs, prevents accumulation of line scale and sludge. Discs are free to revolve and either disc will work equally well against the pressure.

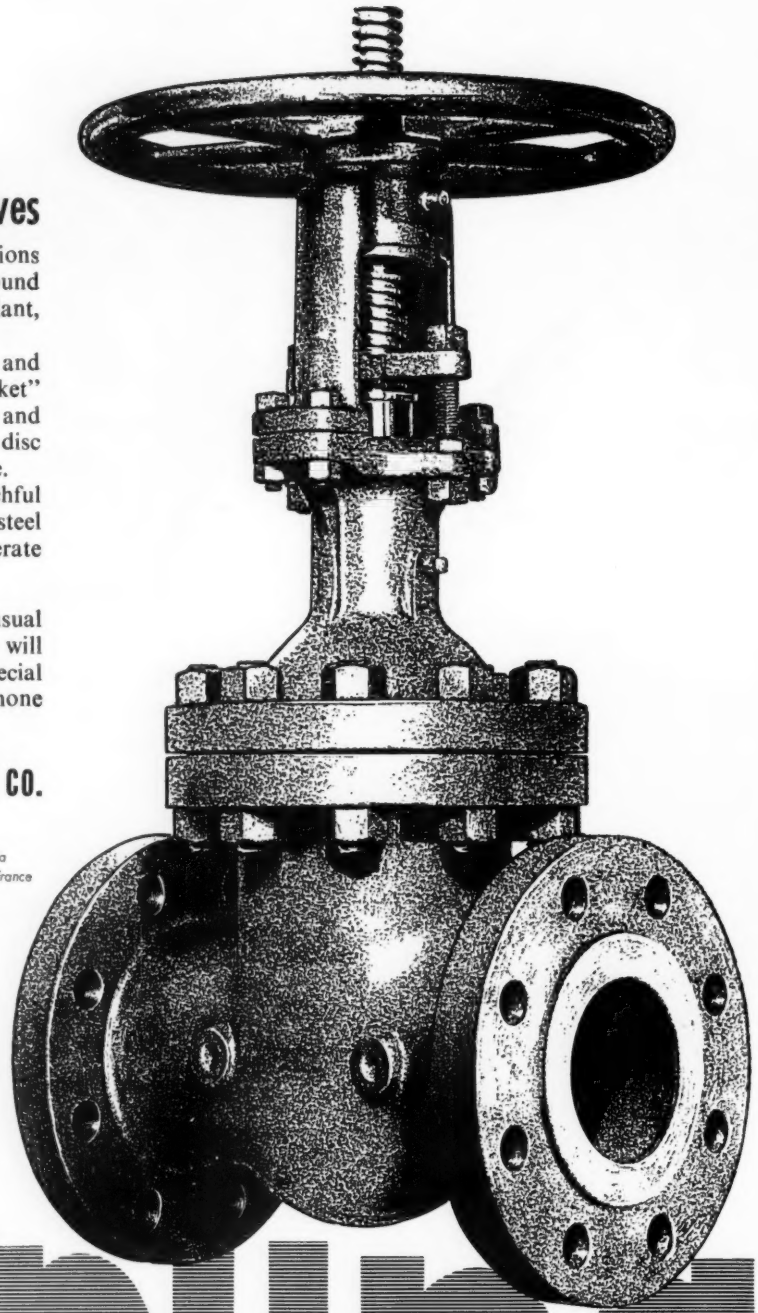
Built by skilled specialists under the watchful eye of continuous inspection, these cast steel gates will seat perfectly, release easily, operate surely . . . *you can depend on Darling.*

ENGINEERING SERVICE. To meet unusual operating needs, Darling staff engineers will be glad to work with you in developing special valves for your services. Write, wire or phone for detailed information.

DARLING VALVE & MANUFACTURING CO.

Williamsport 8, Pa.

Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ontario, Canada
Vannes Darling-France, 23 rue du Commandant Mouchotte, St. Mandé, France

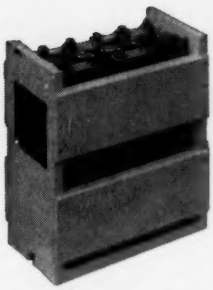


YOU CAN DEPEND ON

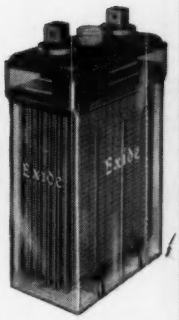
Darling

TRADE DARLING MARK

GATE • BUTTERFLY • CHECK • SPECIAL VALVES • FIRE HYDRANTS

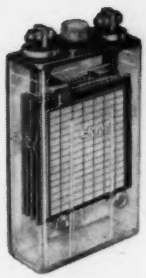


Low-maintenance pocket positive nickel-cadmium

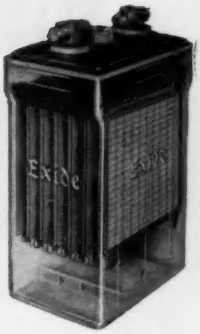


New 20-year Exide-Ironclad tubular with Silvium*

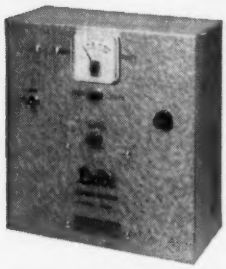
MATCH BATTERY POWER TO YOUR NEEDS AND SAVE MONEY



Flat plate Tytex with Silvium or calcium



Long life Exide-Manchex, Planté type, with Silvium



Trickle or Hi-Lo charger

Constant voltage charger

This is what you get in the Exide Power Package. For your particular application, you need a particular type and size battery for maximum economy. Then you need a particular charger. And you need a certain amount of regular service.

Exide is in the unique position to provide the exact battery, charger and service that your particular application requirements call for. Only Exide offers so broad a line of batteries and chargers. And only Exide has such a well-trained field force of factory supervised service specialists.

An Exide Power Package not only insures you of getting the power you need, but it protects you from overspending on capacity you don't need.

And you get everything from one dependable source. It's your easiest, surest way of getting maximum battery power economy. Write for complete information. Exide Industrial Marketing Division, The Electric Storage Battery Company, Philadelphia 20, Pa.

*Silvium is Exide's patented corrosion-resistant grid alloy

Exide®

INDUSTRIAL MARKETING DIVISION
The Electric Storage Battery Company

ESB

For more facts circle 290 on Reader Service card, p 107

HIGH FUEL BILLS

COST MORE TO IGNORE THAN TO STOP

A Schaub Heat Reclaim System will quickly pay for itself in any plant with a large percentage of high pressure, high temperature boiler returns. A Schaub System will save 10% *more* fuel than any other open type system you now have and substantially more if you have no heat reclaim system at all.

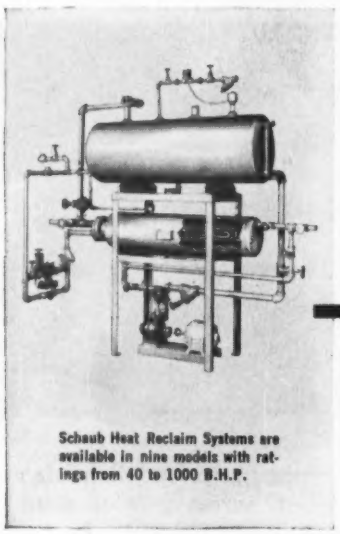
The economy facts are simple. The Schaub System is the *only* open type boiler return system that recovers "flash heat" and supplies boiler feed water up to 300°F. *without the use of live steam.* There is a direct savings of 1% for each 11°F. increase gained by salvaging heat otherwise lost and a much greater net savings due 1) to reducing live steam leakage and 2) to the recovery of re-evaporation "flash". This means that Schaub puts "waste" heat to work for you—and saves you important money.

If you are bothered by big fuel bills, get the full story of how Schaub makes high fuel costs cheaper to stop than to ignore.

Write today for full information.

SCHAUB HEAT RECLAIM SYSTEMS

cut fuel costs at least 10%



Schaub Heat Reclaim Systems are available in nine models with ratings from 40 to 1000 B.H.P.

SEE **SCHAUB** *FIRST*

Specialists in automatic boiler feed and condensate handling systems . . .

boiler return systems • deaerating systems • "pree-heet" systems • transfer and boiler feed pumps • heat reclaim systems • console blow-down recovery systems • condensate return units • power plant specialties
SERVICE COAST TO COAST

FRED H. SCHAUB ENGINEERING COMPANY
5305 Belmont Road, Downers Grove, Illinois

Please send my copy of technical data and Catalog No. 55-D.

Name_____

Company_____

Address_____

City_____ Zone_____ State_____

For more facts circle 291 on Reader Service card, p 107

At 60 F—h_f = 28.06 Btu per lb

At 1.135 psia—h_f = 73.95 Btu per lb

Each lb of chilled water picks up 28.06 – 13.06 = 15.0 Btu

Chilled-water flow for one ton of refrigeration

$$= \frac{12{,}000 \text{ Btu per hr}}{15.0 \text{ Btu per lb}}$$

= 8000 lb per hr per ton

Fig. 5 shows three fluid cycles involved: (1) chilled-water flow from evaporator to cooling coils and back (2) chilled-water vapor flow from evaporator through ejector to condenser and back as makeup (3) boiler steam flow from boiler to ejector to condenser and back to boiler as condensate.

We'll base our calculations on 1 lb of chilled water flowing through the cooling coils. For the throttling process from *3* to *4* in the evaporator the enthalpy remains constant, but part of the chilled water vaporizes at the lower pressure so:

$H_3 = H_4 = h_f + x\, h_{fg}$

$28.06 = 13.06 + x\ 1068.4$

x = 15.0/1068.4 = 0.01405 lb vapor per lb of chilled water entering.

Chilled water remaining in evaporator at $1 = 1.0 - 0.01405 = 0.98595$ lb per lb of chilled water recirculating.

Since makeup from condenser also throttles into the evaporator, part of it evaporates, so:

$H_m = h_f + x_m h_{fg}$

$73.95 = 13.06 + x_m\ 1068.4$

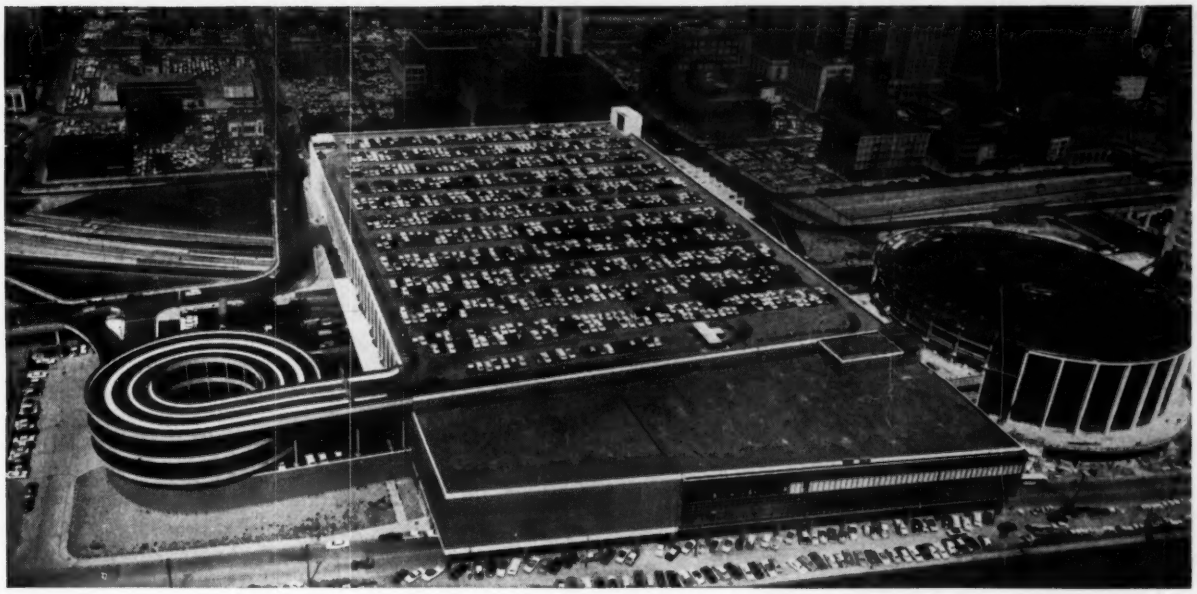
$x_m = 60.89/1068.4 = 0.0570$ lb of makeup vaporized per lb of makeup water entering. Makeup vapor simply recirculates between evaporator and condenser, so total makeup water entering evaporator must replace both chilled-water vapor and makeup vapor formed by the two throttling processes.

Lb makeup vapor per lb makeup water remaining in evaporator = 0.0570/(1.0 – 0.0570) = 0.0604.

Total makeup water to evaporator needed to replace vapors = 0.01405 × 1.0604 = 0.01491 lb per lb chilled water circulating. This is also the vapor removed from the evaporator by the ejector.

Total vapor removed from evapo-

WHAT A HALL!



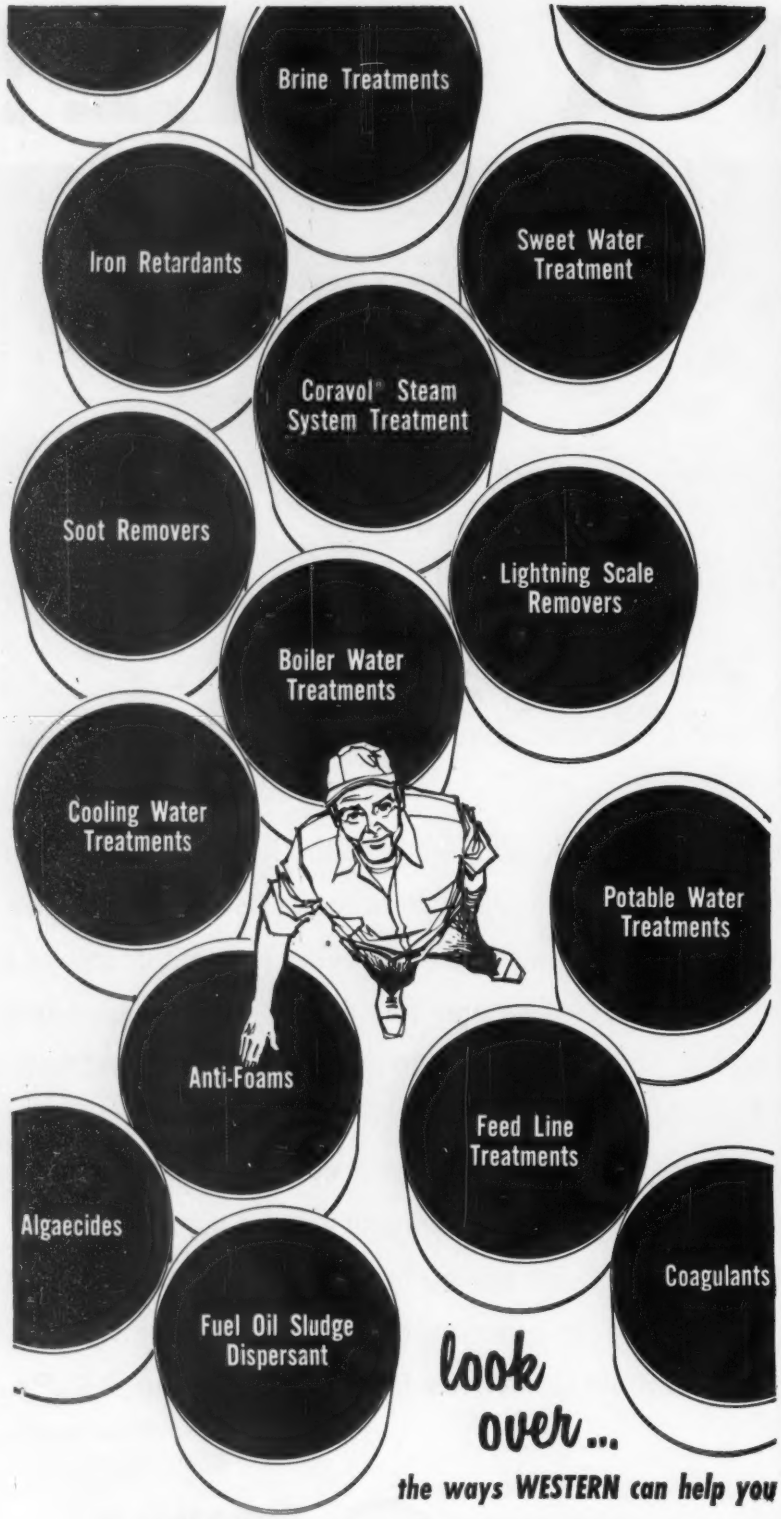
This is Cobo Hall, Detroit's new exhibition building—one of the largest of its kind in the world. The structure is three stories high and has 51 acres of floor space. Inside, there are 32 meeting rooms, a cafeteria, a coffee shop, a banquet hall that doubles as a ballroom and four huge exhibition areas—one area has about 300,000 square feet of exhibit space. ☐ The Hall is so big that they used 330 tons of USS NATIONAL butt-welded and seamless pipe in sizes ½" through 24" O.D. just for the heating and air conditioning systems. They run steam through the heating system at 300 °F. and 35 psi. The air conditioning (system) can carry 10,000 gallons of water a minute at 65 psi. ☐ When you need quality pipe and tubes for power, heating and air conditioning installations—order USS NATIONAL. For information or technical assistance, write National Tube Division, United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

USS and NATIONAL are registered trademarks

National Tube Division of United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors
United States Steel Export Company, New York

This mark tells you a product is made of modern, dependable Steel.



look over...

the ways WESTERN can help you

. . . in the chemical treatment of your WATER—STEAM—FUEL. For over 70 years Western's special formulas and individual technical service have been controlling scale, corrosion, foaming, algae, sludge, soot, and related operating problems. Ask for the brochures that apply to your own needs.

WESTERN CHEMICAL COMPANY

713 Washington St., Kansas City 5, Mo.

For more facts circle 293 on Reader Service card, p 107

Thermo refresher

Begins on page 138

rator = 8000 lb × 0.01491 = 119.3 lb per ton refrigeration.

Boiler steam = 119.3 × 3.1 = 370 lb per ton refrigeration.

Next month we'll start studying gas-vapor mixtures.

Correction

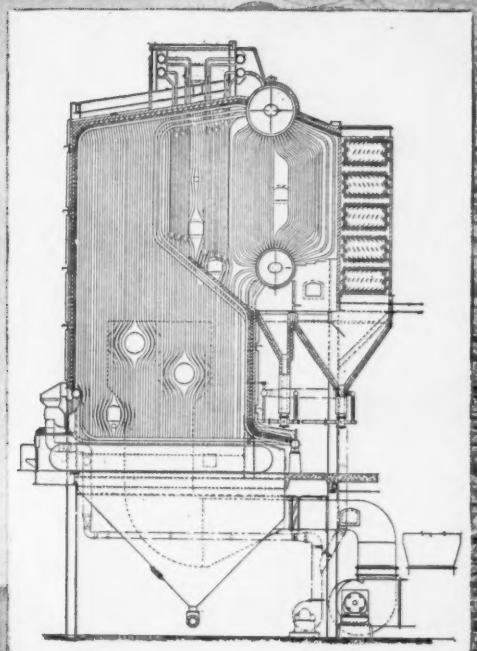
The article *Keep electric tools safely grounded* in May POWER illustrates a cable and plug assembly with a battery clip for grounding, and contains this statement: "Most manufacturers furnish tools with a 3-wire cord, the green wire terminating in a battery clip for attachment to some type of ground such as a water pipe." This is not in accordance with the latest National Electric Code (1959). Manufacturers now must supply a plug with grounding contact. They may supply an adapter for insertion in a convenience outlet, and in this case grounding connection is made by a screw.

Hallam reactor gets housing

Underground stainless-steel vessel, above, will house the atomic reactor for the Hallam, Neb. Nuclear Power Facility which will be completed this fall. The 33-ft-deep 19-ft-dia vessel weighs 50 tons. Supports for the moderator cans and fuel elements are honeycombed in bottom grid plate.

Atomics International is building the sodium-cooled graphite-moderated reactor for the 75,000-kw plant.

FUEL SAVINGS 16%



Longitudinal section of Union Type VO Steam Generator at City of Ames.

JOB: Includes delivering steam for a 12,650 KW Turbo-generator in Municipal Power Plant, City of Ames, Iowa.

STEAM GENERATOR: A Union Type VO Single-Pass (140,000 lbs./hr., 630 psi, 825° F). Fired by continuous ash discharge spreader stoker. Equipped with extended surface economizer for heat recovery. Selected for its adaptability to multi-fuel firing.

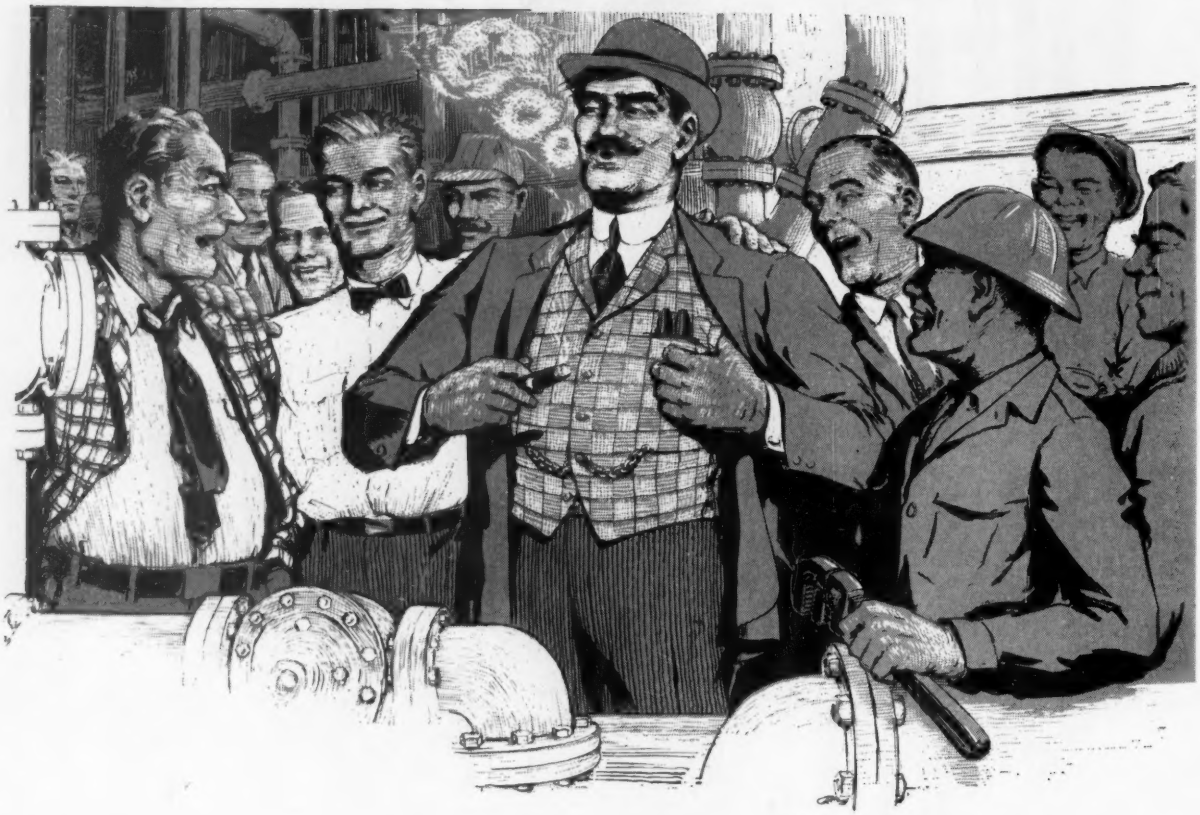
RESULTS: In continuous operation for six months, supplying total steam requirements, the Union VO was credited with fuel savings of 16%.

UNION IRON WORKS • ERIE, PENNSYLVANIA
DIVISION OF RILEY STOKER CORP.

UNION

steam generators

For more facts circle 294 on Reader Service card, p 107



"Now wait a minute," shouted the pipefitter foreman, "I guess I know what I'm doing after 22 years in this business!"

Marmy's wet paper

Not since Bud Stubble went on a binge and then tumbled into No. 3 stock pot back in 1924 had there been as much excitement at the Moosonee Paper Company on Hudson Bay in Canada. Only this time No. 8 paper machine was the star performer.

"What?" barked chief plant engineer Clem Zebina to Roger Lorenzo, his mechanical engineer, "you trying to tell me that No. 8 has been running at 100 feet per minute instead of 700 for over two weeks and you *still* don't know what's ailing her?"

"That's right, Clem," admitted Lorenzo, shifting his bulk uneasily from his port to his starboard column. "We checked and double-checked everything for two weeks, but no soap. I hate to admit it, but we're stuck."

"At least you're honest," sighed Zebina, feeling sorry for Lorenzo's embarrassment. "Hell, it's no crime to be stumped. But why wasn't I told before? You know damn well I'll be called on the carpet when the big boss looks over our sick production report." Then, as an afterthought he shouted, "get the technical file for that machine in here. I want to look it over."

No. 8 paper machine produced a wide variety of specialty papers ranging from 23- to 100-lb per 500 sheets of 24x36-in. stock. At the lower weights, top machine speed was supposed to be 700 fpm.

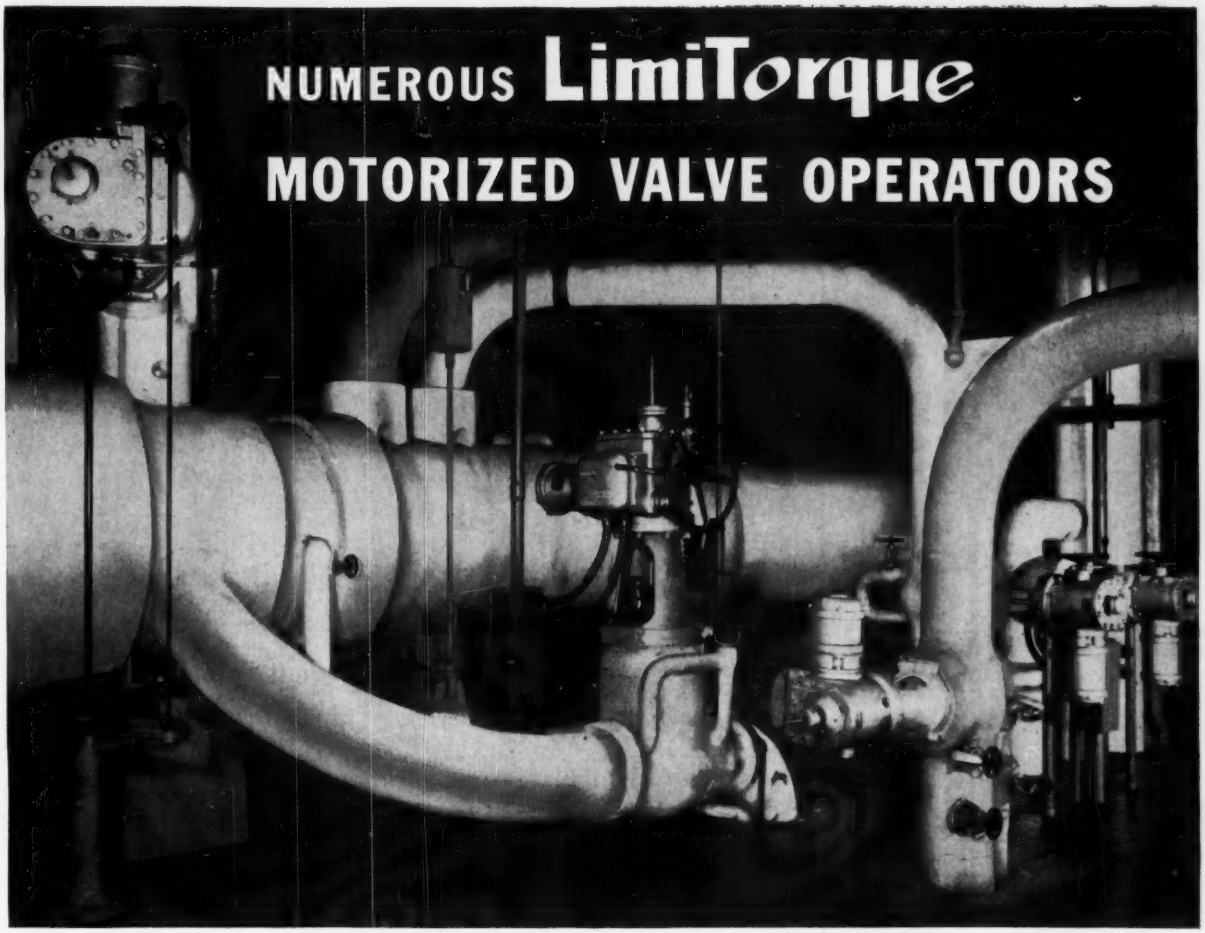
The machine had been speeding along very nicely. Then one day two weeks before, the operators suddenly couldn't get enough drying from the machine's eight dryers. So they did the only thing possible to keep the machine running—reduced her speed. Then they reduced it some more, until finally she was limping at a tired 100 fpm to produce paper of the correct moisture content.

The machine ran at that speed for four weeks. Finally Basil Carbone, the production man, got sore. He called instrument-foreman Bert Parsons and raised the roof. But Bert was no dumbbell about his instruments. Fact is, he was a smart cookie.

"Look, Basil," said Bert good-naturedly, "the instruments are OK. You take my word for it. Just have the steam boys check the drainage system to those dryers. That's all that's wrong."

Trapped condensate from each dryer in the system ran to a condensate header, flowed down to the condenser, then drained into the basement vacuum tank. The vacuum was maintained by a vacuum pump hooked into the top of the tank, while a condensate pump connected to the tank's bottom picked up the 180-F condensate and pushed it into a hotwell. That pump had a large gate valve on its suction side and a check valve on the discharge side.

After leaving the plant engineer's office, Roger Lorenzo hurried to the basement and checked the vacuum tank's condensate level. The level was high, way up over the top nut of the gage glass. Roger's first guess was that the condenser was leaking, thus flooding the tank. But a quick



. . . are used at RIDGELAND STATION OF COMMONWEALTH EDISON CO.

The huge Ridgeland Generating Station, which has a capacity in excess of 600,000 KW, uses LimiTorque Push-Button Motorized Valve Operators for such applications as Inlet and Outlet 12″ Feedwater Valves operating at 2300 p.s.i. and 410° F. temperatures, 6″ Drain Valves operating at 600 p.s.i. and 360° F., 4″ Superheated Steam Line Valve operating at 1800 p.s.i. and 1050° F. (see photo above). Other LimiTorque Controls are used throughout this great plant, which was completed in 1954.

Wherever automatic, remote valve operation is required, LimiTorque will provide rapid, precise control under a wide range of operating conditions. Actuated by electricity, hydraulic pressure, air, or high pressure gas, LimiTorque can be readily fieldmounted on existing valves. For specific applications, contact your valve manufacturer or nearest LimiTorque Sales-Engineering Office.

Be sure to send for our complete catalog I-60 which illustrates and describes the construction, operation and installation of LIMITORQUE.

THERE IS NO SUBSTITUTE FOR

LimiTorque®

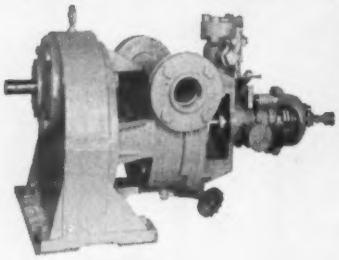
PHILADELPHIA GEAR CORPORATION
KING OF PRUSSIA (SUBURBAN PHILADELPHIA), PA.
Offices in all Principal Cities

PRECISION GEARS • INDUSTRIAL GEARS • SPEED REDUCERS • FLUID MIXERS • FLEXIBLE COUPLINGS
Limitorque Corporation • King of Prussia, Penna.

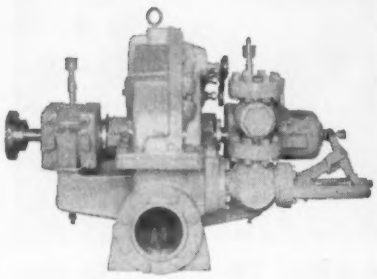
For more facts circle 295 on Reader Service card, p 107

CARLING

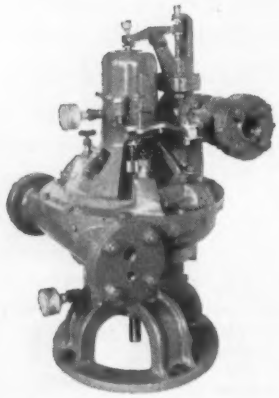
For 40 Years



the Quality Name



in TURBINES



WRITE FOR BULLETIN 20—C-3

CARLING TURBINE BLOWER CO.

.7 NEBRASKA ST., WORCESTER, MASSACHUSETTS

Representatives in Principal Cities

circle 296 on Reader Service card, p 107

Marmaduke

Begins on page 148

check showed him that the temperature in the tank was over 200 F. He knew it would have to be much lower if cool circulating water were leaking into the system.

Then he discovered that the level in the vacuum tank was so high that the water was actually being siphoned out at the top by the vacuum pump. He next reasoned that the condensate pump wasn't up to capacity. The pump's speed was controlled by a water-level regulator on the vacuum tank.

Lorenzo stood there watching the condensate pump. Suddenly it came to him that he was no longer alone, as the chief plant engineer, the production man, the instrument foreman, the pipe-fitter foreman, the master mechanic and the mechanical superintendent filed into the basement machine room.

"It's that cockeyed pump," said Roger when he saw his audience. "If she were pumping to capacity the vacuum tank wouldn't overflow."

"Forget about the pump being haywire," growled the master mechanic. "We had her apart last week and she's perfect."

"I'll bet a month's salary against a piece of corroded condensate pipe that suction valve's gate has dropped off the stem," opined Jack Timmerman, the pipe-fitter foreman. "I've seen that happen before."

"Maybe you got something there, Jackie old boy," said Lorenzo. "Let's take the pump off the line and have a looksee."

Ten minutes later the valve had been opened: it was in perfect shape. All the while the various department heads stood around, each putting in his oar from time to time.

Just as the valve was closed up and the pump started, Gus Wiedke, the utility chief, barged in with a tall stranger wearing a gray bowler and a checkered vest.

"Look who blew into this forgotten corner of the globe, gentlemen," announced the chief, beaming from bow to stern. "It's my old shipmate Marmaduke Surfaceblow, chief on the *SS Queen Victoria*. His ship's going to load these 2000 rolls of newsprint we ran off for New York."

continued

FLEXIBLE TUBING

RUGGED AND STRONG FOR LASTING SERVICE

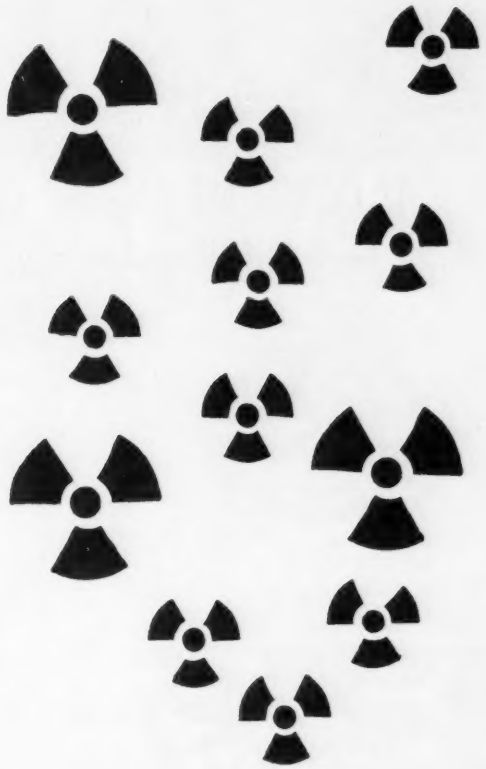
. . . that is Penflex Flexible Tubing. Especially engineered for punishing industrial service . . . to defy abrasion, crushing, heat in conveying liquids, chemicals, powders, granular material, semi-solids.

Penflex makes all types and sizes (⅛" to 24" I.D.) for every industrial application. For catalog and details write to Pennsylvania Flexible Metallic Tubing Co., Inc., Route 30, Paoli, Pa.

PENFLEX

TIGHT AS A PIPE BUT... FLEXIBLE

circle 297 on Reader Service card, p 107



Gilsulate

underground hot pipe insulation

has been installed in
12 Atomic Energy Commission plants in the United States
and 3 plants in foreign countries.

In these jobs—as in hundreds of installations in schools, airports, public and private housing projects, industrial, and military installations made during the past ten years —GILSULATE has provided maintenance-free underground hot pipe insulation at low cost. For example, one atomic energy plant first used GILSULATE in 1954 and has ordered additional installations every year since then, for a total of more than 400 tons.

The superiority of GILSULATE is the direct result of extensive product research, independent laboratory and field tests, to provide a product that assures low installation cost, thermal efficiency and long service life. And every GILSULATE job is *engineer-supervised* from start to finish.

We will be pleased to send you technical information and the name of your nearest GILSULATE distributor. Write to the office listed below.

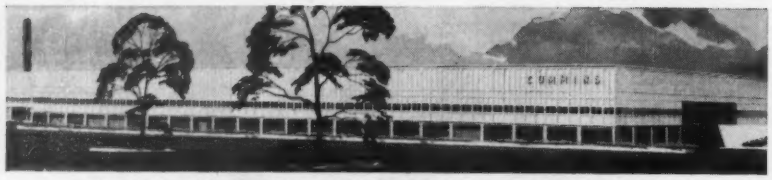
The insulation for superior protection of underground hot pipes

Gilsulate®

American Gilsonite Company | Municipal Airport P. O. Box 15 | Salt Lake City, Utah

Affiliate of Barber Oil Corp. & Standard Oil Co. of California • Distributors in Principal Countries of the World

For more facts circle 298 on Reader Service card, p 107



At CUMMINS ENGINE COMPANY'S New Test Building ··· water pump systems run safely and silently

Figure 636 Globe-Type Silent Check Valve installed at Cummins' Test Building. Available for 3" to 24" lines.

Eighteen Williams-Hager Silent Check Valves are installed on boiler feedwater, condensate and vacuum pump lines, as well as dynamometer and engine cooling water pump systems, in the new Engine Test Building at Columbus, Indiana. These check valves operate the instant flow reversal starts, eliminating pressure surges and resulting water hammer before they are created. Result: assured silence and safety of liquid systems.

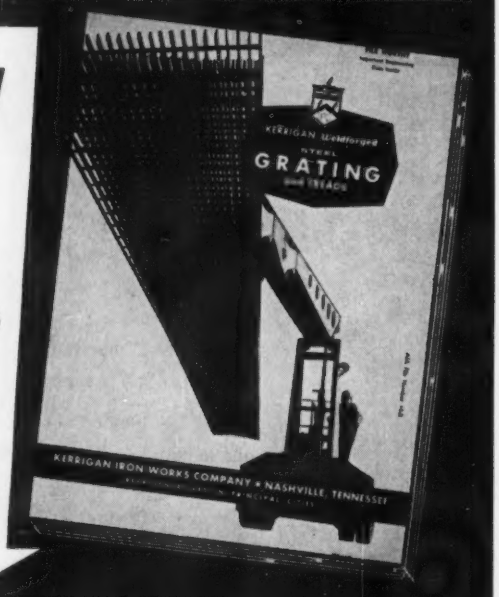
WILLIAMS • HAGER Silent Check Valves

Write for Bulletins: No. 654 on Valves; No. 851 on Cause, Effect and Control of Water Hammer; No. 659 on Pressure Loss Tests.

The WILLIAMS GAUGE CO., Inc.
160 Stanwix Street
2 Gateway Center • Pittsburgh 22, Pa.
Our 75th Year • 1886-1961

For more facts circle 299 on Reader Service card, p 107

NEW EASY-TO-USE STEEL GRATING CATALOG SEND NOW FOR YOUR FREE COPY



Dept. P-8 KERRIGAN IRON WORKS CO. Nashville, Tenn.

NAME _____

FIRM NAME _____

CITY _____ STATE _____

For more facts circle 300 on Reader Service card, p 107

Marmaduke

Begins on page 148

Introductions followed, with Mr Surfaceblow shaking hands all around as he puffed on a long black cigar.

"Marmy's the man I told you about who solved that main-engine knibbling-pin problem on the *SS Karachi*, back in 1922. It sure took some masterminding to nail down that brain teaser, eh, Marmy?" guffawed Gus, breaking into raucous laughter.

"Sounds interesting," exclaimed Clem Zebina politely, after the utility chief quieted down, "but we're having a bit of a problem here ourselves."

"Then here's the very man to steer you on the right course, gentlemen," cut in Wiedke, slapping Marmy on the shoulder.

Two minutes later Roger Lorenzo was briefing the visitor on the problem of the lazy dryers. Marmy listened, puffing away and blowing smoke rings into the air. By then a dozen men had gathered around, waiting for the results of that top-brass confab so they could start the paper machine.

"Would you like to see the operating data and piping diagrams for those dryers?" asked Lorenzo, when he saw Marmaduke's apparent interest.

"BILGEWATER on your operating data," suddenly roared Marmy in his foghorn voice. Then before his startled audience could answer, he went on, "just tell me one thing—when did this machine first give you trouble?"

"Why, about two weeks ago," was Lorenzo's surprised answer.

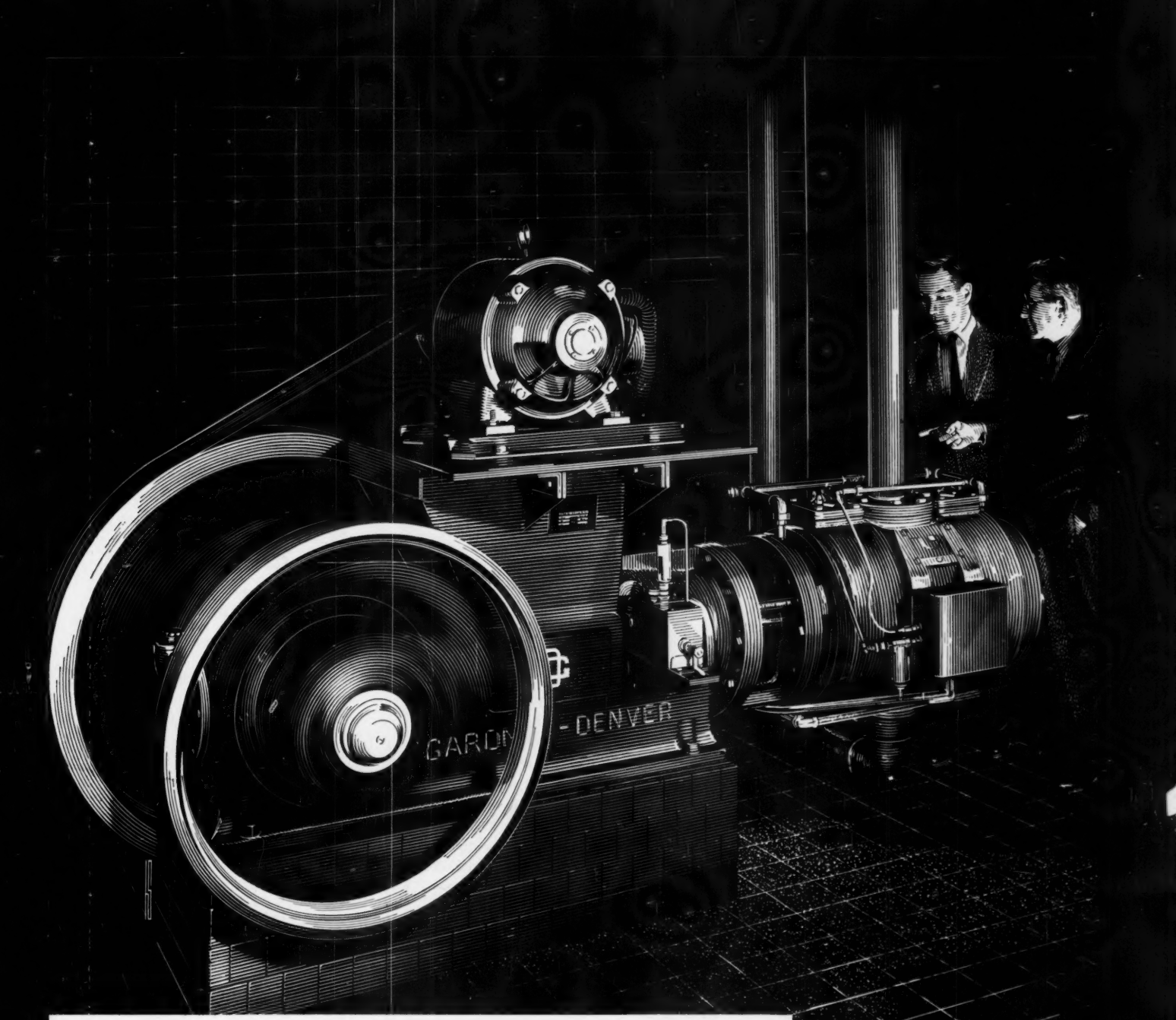
"Was your machine running full capacity right up to that time, or did she have to be slowed down gradually?" shot back Marmy.

"She was running at 700 fpm and we had to slow her to 100 ft within an hour to get the proper moisture content," snapped Lorenzo, taking offense at these abrupt questions.

The men were beginning to eye this unusual ship's engineer resentfully. Suddenly Marmy blurted, "I see you boys are mighty good housekeepers. Your piping down here is really shipshape. And it's all painted my favorite shade of sea green.

continued

circle 301 on Reader Service card, p 107



"No more oil to spoil our quality"

. . . the reaction to Gardner-Denver oil-free compressors. They protect product quality by delivering pure, clean air—air that never has a drop of oil in it. So if even a trace of oil in your air line is too much, see Gardner-Denver first. Write for bulletin CRC-10.

Gardner-Denver Company, Quincy, Illinois—Offices in principal U.S., Canadian and Mexican cities
In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Ave., Toronto 16, Ontario

International: Gardner-Denver International Division, 233 Broadway, New York 7, N.Y.
International Offices: Buenos Aires, Argentina; Artarmon, N.S.W. Australia; Brussels, Belgium; Rio de Janeiro, Brazil; Santiago, Chile; Barranquilla, Colombia; Lima, Peru; Ndola, N. Rhodesia; Salisbury, S. Rhodesia; Johannesburg, Transvaal

GARDNER-DENVER Since 1859

EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

GARDNER - DENVER

INDUSTRIAL and ELECTRICAL EQUIPMENT FROM POLAND

- Three phase A.C. and D.C. motors
- High and low voltage switchgear
- Electric and electronic measuring instruments and kWh meters
- Lighting circuit accessories for industrial, commercial and domestic installations
- Primary cells and storage batteries
- Power, distribution, regulating and welding transformers
- Electrical equipment for mining
- Electric furnaces and drying ovens of various types
- Radio and telecommunication equipment
- Battery operated lift trucks
- Power and steam generating plants for industrial and system power stations
- Central heating boilers

For full information on these superior products, visit the

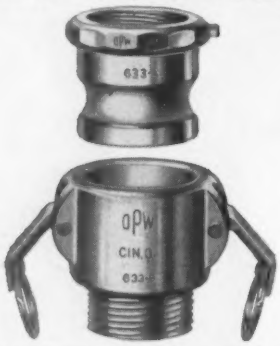
POLISH PAVILION
Chicago World Trade Fair

Elektrim
Czackiego 15/17
Warsaw 2, Poland
cable: Elektrim-Warszawa

circle 302 on Reader Service card, p 107

IT'S EASY

WITH KAMLOK QUICK COUPLERS



You save production time . . . when you replace time-wasting hose and pipe connections with Kamlok Quick Couplers. No tools needed. Your operator can do the job himself. Just fit together and pull the two cam arms down. Use them wherever your hose or pipe connections are periodically uncoupled (once a week or oftener). We probably have one to fit your needs. Why not send for more information? Inquiries are invited.

Fastest—safest—surest couplings known. 5

OPW-JORDAN | 6013 Wiehe Rd. Cincinnati 13, Ohio EL 1-1352

circle 303 on Reader Service card, p 107

Marmaduke

Begins on page 148

When was this paint daubed on, by the way?"

At that question a few eyebrows were raised, as if to ask what the dickens the paint job had to do with slow-drying paper. Clem Zebina piped up, almost absent-mindedly, "I guess about a month ago, wasn't it, Roger?"

"OK," roared Marmy, before Roger could confirm his boss's answer. "Your riddle's solved." Pointing to the large check valve, he bellowed, "there's your gremlin. That check valve's installed stern-end-to. It's the only spot on that nice green discharge line that isn't painted. So you must have given the old valve the deep six recently."

That ruffled Jack Timmerman's feathers. "Now wait a minute," shouted the pipe-fitter foreman, "I OK'd that valve myself after it was installed. And she's put in right. I already told Roger that when he had the same idea. Hell, I haven't been installing valves for 22 years not to know which way a check swings."

"If Jack says the valve's installed properly, for my money it is," said Roger Lorenzo, coming to his rescue.

Marmaduke just stood there blowing smoke rings and looking at the foreman. Finally he said calmly, "OK, Mr Pipe-Fitter Foreman, so you know how to install check valves. But smarter people than you make mistakes. Sometimes we even see things cockeyed. Yank off the bonnet like a good guy. I'm betting that flapper is swinging against the discharge stream. If the valve's installed according to Hoyle I'll blow you to a free dinner aboard my ship. If I'm right, you buy me one ashore. Is that fair?"

"You win," said the foreman, realizing that Marmy had backed him into a corner. Calling to a pipe fitter, he said, "Bruce, you and Joe installed that valve. Yank off her bonnet and have a look inside."

That evening at the Moosonee Inn along the shore the boys from the paper mill were entertaining Marmaduke Surfaceblow.

"You know, Marmy," said Clem, after offering a toast to this honored

P.F.I.
THE PIPE FABRICATION INSTITUTE

These Members have participated in research and the development of advanced shop fabrication methods . . .

CINCINNATI, OHIO
Alco Products, Incorporated

DENVER, COLO.
The Stearns-Roger Manufacturing Co.

HARRISON, N. J.
Chas. F. Guyon, Inc.

HOBOKEN, N. J.
Cornell & Underhill, Inc.

HOLMES, PA.
Nelson Company

NEW YORK, N. Y.
The M. W. Kellogg Company
Power Piping Division

PHILADELPHIA, PA.
W. K. Mitchell & Company, Inc.

PITTSBURGH, PA.
Blaw-Knox Company
Power Piping Division

PITTSBURGH, PA.
National Valve & Manufacturing Co.

PITTSBURGH, PA.
Pittsburgh Piping & Equipment Co.

PROVIDENCE, R. I.
Grinnell Company, Inc.

ST. LOUIS, MO.
Midwest Piping Div. Crane Co.

TOLEDO, OHIO
The Shaw-Kendall Engineering Co.

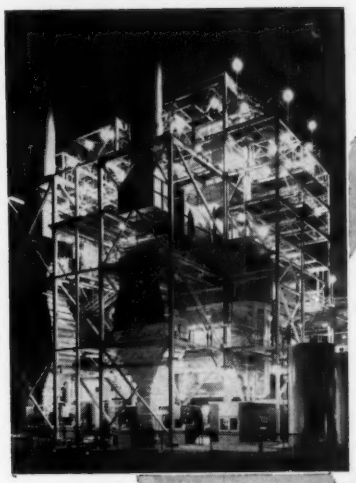
WILMINGTON, DEL.
Benjamin F. Shaw Company

ASSOCIATE MEMBERS

NORWOOD, MASS.
Mercury Piping Company, Inc.

SAN FRANCISCO, CAL.
Western Piping & Engineering Co., Inc.

CONSULT A PIPE FABRICATION INSTITUTE MEMBER FOR YOUR PIPE FABRICATION NEEDS



WHATEVER ANGLE YOU TAKE

Whether it's assuming complete responsibility from blueprint to finished assembly of piping . . . meeting exacting specifications . . . handling every phase of fabrication — consider from every angle the many advantages of using the dependable services of a P.F.I. member.

Each member is a piping specialist, particularly experienced in the fabrication of high pressure or high temperature installations. Including applications in nuclear energy and missile plants.

As a group, P.F.I. members have contributed substantially to the advanced technology of modern fabrication techniques, especially in the use of new metals and alloys.

So, for complete assurance of meeting your specific piping needs, remember to contact a member of the Pipe Fabrication Institute . . . you'll probably save money and you'll surely avoid expensive mistakes or the costly inefficiency of inadequate piping.

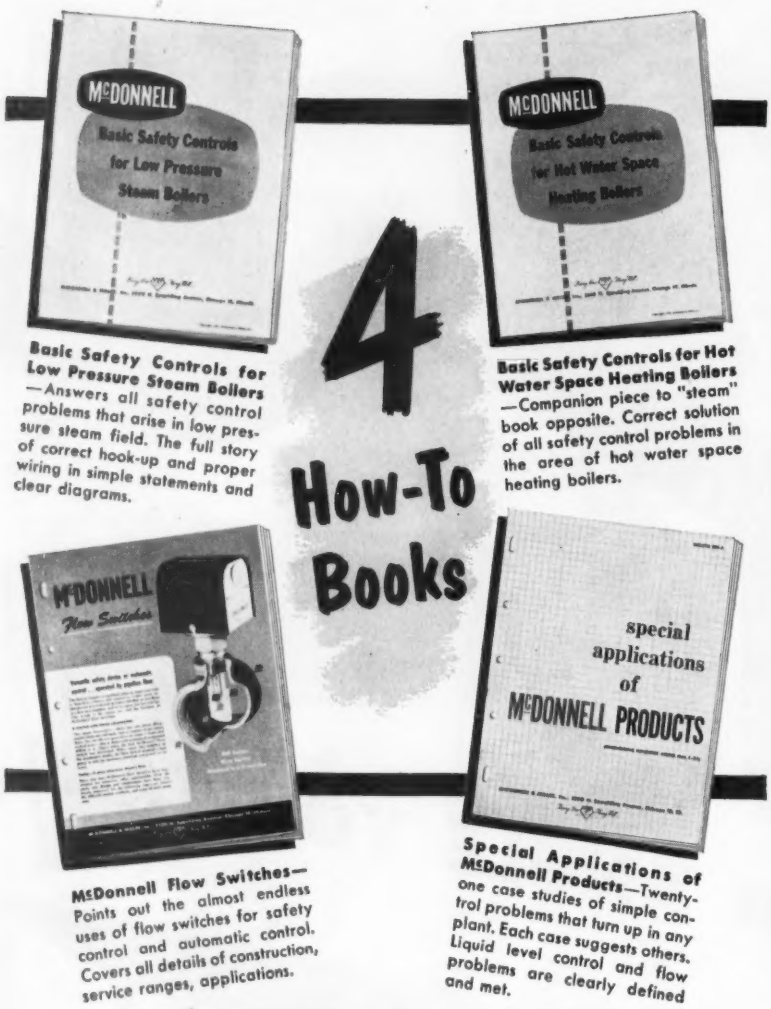
P.F.I.

THE PIPE FABRICATION INSTITUTE

SEE LIST OF P.F.I. MEMBERSHIP ON OPPOSITE PAGE

PIPE FABRICATION INSTITUTE • ONE GATEWAY CENTER • PITTSBURGH, PA.

For more facts circle 304 on Reader Service card, p 107



Basic Safety Controls for Low Pressure Steam Boilers—Answers all safety control problems that arise in low pressure steam field. The full story of correct hook-up and proper wiring in simple statements and clear diagrams.

Basic Safety Controls for Hot Water Space Heating Boilers—Companion piece to "steam" book opposite. Correct solution of all safety control problems in the area of hot water space heating boilers.

McDonnell Flow Switches—Points out the almost endless uses of flow switches for safety control and automatic control. Covers all details of construction, service ranges, applications.

Special Applications of McDonnell Products—Twenty-one case studies of simple control problems that turn up in any plant. Each case suggests others. Liquid level control and flow problems are clearly defined and met.

—for every engineer

Here are four bulletins that can make a basic contribution to the things every operating man seeks...more efficient operation... automatic operation...safer operation.

Read the brief descriptions of these booklets. ***Use the coupon to request any or all of them.***

McDONNELL & MILLER, Inc.
3506 N. Spaulding Ave., Chicago 18, Ill.
Doing One Thing Well

COUPON BRINGS THEM—

Send me a copy of bulletin(s) checked:

- ☐ Steam Booklet, L-711
- ☐ Hot Water Companion Booklet, P-30-C
- ☐ Flow Switch Bulletin, FS1
- ☐ Special Application Booklet, ERS-A

Company_____

Address_____

City, Zone, State_____

By_____

Mail to: McDonnell & Miller, Inc., 3506 N. Spaulding Ave., Chicago 18, Ill.

Marmaduke

Begins on page 148

guest, "for four weeks my boys were going off their rocker trying to find that trouble. You blow in and put your finger right on the sore spot. What's the answer?"

"No mystery," roared Marmaduke, turning bottoms-up on his glass of Sandpaper Gin. "First place to look for headaches in any mechanical system that's been running OK is where something has been disturbed or newly installed—so play the percentages and always double-check those places first. Even if you're as sure as Jack here was that he saw that clapper swinging the right way . . . check again. I'm suspicious of a system that's been worked on until everything has been running shipshape for a long time."—*SME*

Marmy's mail

MARMY THE LAST?

Looks like Marmaduke is one of the last of that fine old breed of up-and-down marine engineers. How many of today's engineers sailed on a coal-burning job with a quadruple engine? We nursed the engine, knew all about her: the crossheads, bottom ends, guide shoes, guide plate and truss.

And how about the Weir feed pump. That pump was human. She'd stop, you'd grab a spanner to adjust her valve (yes, you could adjust her cutoff) and as you got to her she'd start up with a bang. So you'd hang up the spanner and soon as you did she'd stop. But who hears of these pumps today?

Anyway, I'm sure Marmy is one of the few engineers who has fond memories of those old ships' power plants.

W KNOX, *St. John's, Newfoundland*

FRIENDS IN BRAZIL

I compliment POWER for the excellent information you publish. My best wishes to that salty engineer, Marmaduke Surfaceblow. We down here in Brazil love him.

N SHERMAN, *Estado do Rio, Brazil*

CANADA SAYS 'HELLO'

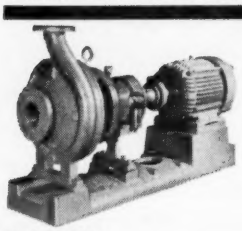
Chaps I know and bend elbows with now and then at the club (they are

GOULDS PUMPS, INC.

Dept. PO-81, Seneca Falls, New York, specialists in pumps

The largest plant of its kind in the world *plus* over 100 years' experience in pump manufacturing—that's what equips us to answer all your liquid-handling needs. You have a wide line of Goulds pumps to choose from. Complete details on any pump are available in the Bulletins indicated. Write for your copy.

ATLANTA • BOSTON • BUFFALO • CHICAGO • HOUSTON • NEW YORK • PHILADELPHIA • PITTSBURGH • SHREVEPORT • TULSA • REPRESENTATIVES EVERYWHERE

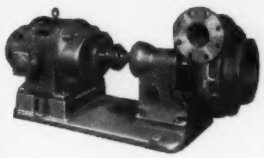


Model 3195

INTERCHANGEABLE CHEMICAL PUMPS

11 pump sizes with same overall length, 23 in. Capacities to 775 GPM, heads to 300 ft. tdh. Working pressures to 275 psig. Standard in ductile iron, 316 stainless steel, Gould-A-Loy 20. Handles liquids to 500°F. Maximum interchangeability of parts and dimensional interchangeability of models give you greatest flexibility and coverage.

BULLETIN 725.1.

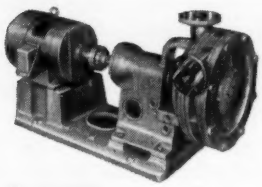


Model 3755

FRAME MOUNTED CENTRIFUGALS

Built in 24 sizes, with capacities up to 4000 GPM and heads up to 400 ft. Designed for standard electric motor drive; readily adaptable for belt drive. A substantially built line for general and special applications with many new improvements.

BULLETIN 715.1.

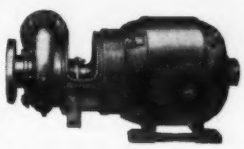


Model 3708

GOULDS-PFAUDLER GLASSED PUMP

Revolutionary new pump designed for handling corrosive liquids. All parts in contact with liquid are glass—fused to metal. Handles all acids except hydrofluoric, and all alkalies to pH 12. Four sizes, with capacities to 700 GPM, heads to 140 ft.

BULLETIN 725.2.

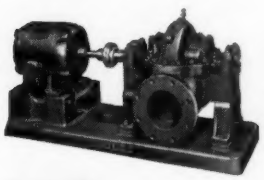


Model 3655

CLOSE-CUPLD CENTRIFUGALS

Single-stage pumps built in 23 sizes with a capacity range from 5 to 2000 GPM and heads up to 400 ft. Embody top horizontal discharge, closed impeller, machined stuffing box, fully protected shaft. Wearing parts easily renewable.

BULLETIN 710.1.

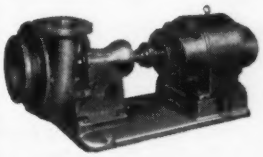


Model 3405

DOUBLE-SUCTION CENTRIFUGALS

Capacities from 100 to 6400 GPM. Heads up to 525 ft. Three shaft and rotating parts assemblies provide for 70 sizes and 140 pump combinations. Horizontally split casing.

BULLETIN 721.6.

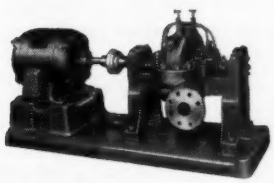


Model 3189

OPEN IMPELLER CENTRIFUGALS

Highly efficient open impeller pumps available in 13 sizes for both motor and belt drives. Capacities up to 3000 GPM, with heads up to 180 ft. at 1750 RPM. Well suited for irrigation, general industrial processes, and slurries.

BULLETIN 720.4.

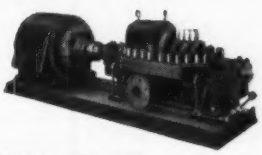


Model 3305

TWO-STAGE CENTRIFUGALS

Ten sizes provide heads up to 1000 ft., capacities to 3000 GPM, depending on heads. Horizontally split casing. Opposed impellers, with labyrinth diaphragm for maintaining thrust balance.

BULLETIN 722.6.

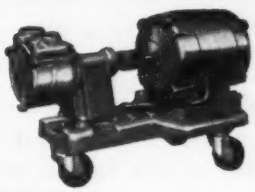


Models 3330-3360

MULTI-STAGE CENTRIFUGALS

Medium- and high-pressure multistage pumps. Model 3330 is furnished in sizes from 3 to 8 inches, 2 to 6 stages, with capacities ranging from 40 to 2100 GPM, heads to 950 ft. Model 3360 furnished in 3, 4, 6, and 8 inch sizes, up to 8 stages, with capacities ranging from 50 to 2600 GPM, heads to 3400 ft.

BULLETINS 722.1 and 722.4.



Model 2520

CENTRIPETAL SCAVENGER PUMP

Centripetal action lets it pump liquid, air, liquid *and* air. Use it for transfer, cleaning-up, or pilot plant operations. Compact, lightweight, portable. All-iron or stainless steel construction. Capacities to 60 GPM, heads to 80 ft.

BULLETIN 725.6.

MODULAR VERTICAL PUMPS

SUMP

For pit depths to 20 ft. in 6 inch increments. Both wet and dry pit types available in capacities up to 3180 GPM, heads to 190 ft. Single and duplex units. Full automatic control. Modern design using standard parts permits quick shipment at most economical cost.

BULLETIN 726.2.

PROCESS

Especially designed for handling corrosive liquids in the chemical process and allied industries. Normally supplied in 316 stainless steel constructions, but materials to suit user's requirements can be furnished on application.

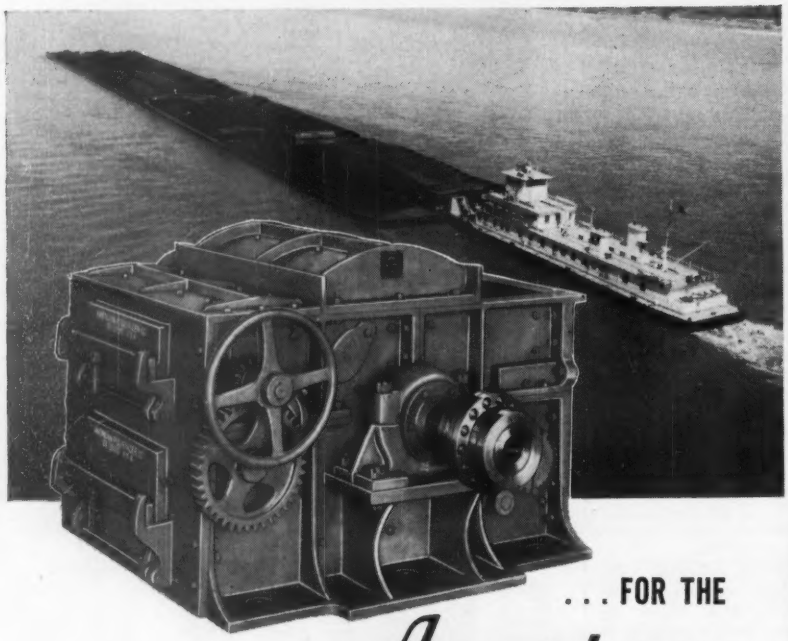
Capacities to 720 GPM. Heads to 190 ft. For heavy-duty service under most severe applications.

BULLETIN 727.1.

GOULDS PUMPS

For more facts circle 306 on Reader Service card, p 107

12 BARGE LOADS OF COAL IS BUT A SINGLE DAY'S WORK



. . . FOR THE *American*

COAL CRUSHER

. . . and capacity for work is but one of the advantages

The American Coal Crusher will keep on operating at high performance for many years — just like old man river.

At the mine or in the power plant, American Coal Crushers continue to set endurance records — with a total cost of operation of less than 1¢ a ton . . . an average parts replacement costs $.0012 per ton.

Patented manganese steel shredder rings, reversible for double life, manganese steel liners to protect the crushing chamber, and strong ribbed steel frames are among the construction features that give American Crushers the ruggedness that mean savings to every owner.

Figure American Coal Crushers in your cost analysis when you figure ways to better profits.

Write for Bulletin on American AC Coal Crushers

American **PULVERIZER COMPANY**

ORIGINATORS AND MANUFACTURERS OF RING CRUSHERS AND PULVERIZERS

6007 1349 MACKLIND AVE. ST. LOUIS 10, MISSOURI

Marmaduke

Begins on page 148

leading engineers in aluminum, paper and chemical plants) all read Marmy and say "hello" to the old boy.

W BUCKSHEE, *Shawinigan S, Que.*

GOT A BONUS . . .

While in New York City recently attending the ASME conferences, I visited the Central Library at Fifth Ave and 42nd St to look up a few technical books. Looking through the *E*'s, I came upon several cards, one on a book of Marmy stories. I'd often heard that the Marmy stories were in book form—I finally had my hands on the shiny red book.

Why doesn't McGraw-Hill print all his stories in one book, instead of only 21 of them? There must be over a hundred published to date.

J MCLOUTH, *Salt Lake City, Utah*

BOOK OF WORLD TRAVELS?

Why not a Marmy book with a complete collection of his world travel yarns? His experiences reach from submarine to ocean liner. I'm sure a complete collection of his stories to date (I have been reading them since 1948—must be over 100) between hard covers would be welcome to engineers the world over. Such a book of lighter reading could be frosting for the cake of any engineer's library.

C C STRONG, *Houston, Texas*

EDITOR'S NOTE: *Tell it to the McGraw-Hill Book Co. Suggestion has been made before. Such a book could be placed in every technical library sold by the company. What do you Marmy fans think?*

GAL UNDERSTANDS MARMY

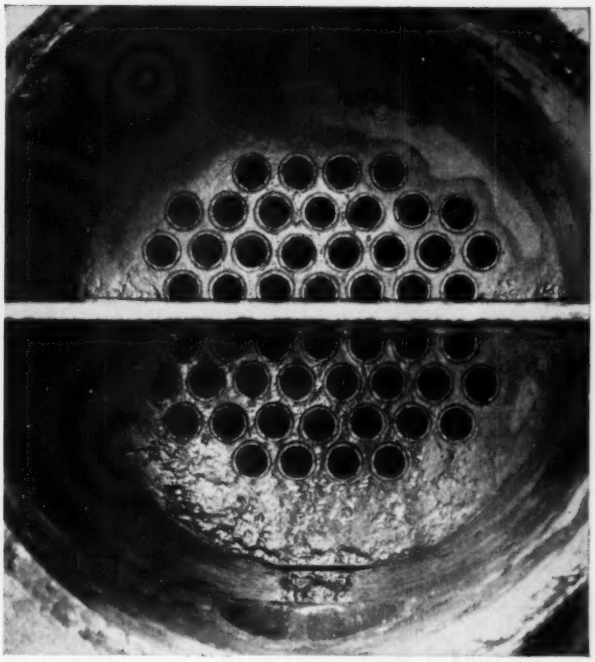
I have been reading the Marmy stories in our plant library for several months. What a delightful person he is. So full of enthusiasm, adventuresome spirit and zest for living. I am also intrigued that a non-engineer like myself can get so caught up in the problems that Marmaduke solves each month.

Since reading his stories, I have mentioned them to two engineer friends. Imagine my surprise when they both told me they have been reading him for years!

BARBARA PETERSON, *Greenwich, Conn.*

Descale equipment quickly, safely, —without dismantling!

BEFORE—This condenser was badly clogged with hard-water scale. Mechanical cleaning of the tubes would have been difficult, time-consuming and costly. To use hydrochloric acid would pose danger to nearby equipment and personnel.



AFTER—It was easily cleaned *without dismantling* by circulating a water solution of a sulfamic acid-based cleaner for an hour. Short downtime, *no* danger to equipment and complete safety for personnel!

Use a dry-acid cleaner based on Du Pont Sulfamic Acid

They're effective. Dry-acid cleaners dissolve most water-side deposits found in condensers, boilers, compressor jackets, heat exchangers, etc. Yet they're much less corrosive to metal than hydrochloric-acid cleaners.

They're easy, safe. Just dissolve the solid cleaner in water and circulate through the equipment. No danger of broken carboys, spilled liquids or toxic fumes—glasses and gloves are the only protective clothing needed!

They're economical, fast. 1 lb. of dry cleaner does the job of 1.3 lb. of 28% hydrochloric acid—you save on shipping, handling, storage and downtime (because there's no dismantling).

Horizontal and vertical condensers, stills, compressors, etc., are readily and economically descaled in place with cleaners based on Du Pont Sulfamic Acid. Plant personnel do the job with a minimum of equipment.

Ask your water-treatment company's technical representative about dry-acid cleaners; chances are, he can supply you. Or send the coupon for booklet and names of formulators offering dry-acid cleaners based on Du Pont Sulfamic Acid.

DU PONT
REG. U. S. PAT. OFF.
BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

E. I. du Pont de Nemours & Co. (Inc.)
Industrial and Biochemicals Department, N-2545P,
Wilmington 98, Delaware.

Please send your "Descale" booklet and names of formulators offering cleaners based on sulfamic acid.

*Name*_____

*Company*_____

*Address*_____

*City*_____ *State*_____

For more facts circle 308 on Reader Service card, p 107

Powerscope . . . A selective look at

Roman energy conference

Some 400 specialists from 61 countries are expected to attend the Rome (Italy) Conference on New Sources of Energy. Sponsored by the United Nations, it will be held from August 21 to 31, 1961. Of the 250 papers to be discussed, 118 deal with solar energy, 77 with geothermal energy, 40 with wind power and 15 examine general problems and combined use of different energy forms. Working languages of the Conference will be English and French, with simultaneous translations into Russian, Spanish and Italian. Alfred G Katzin of the UN Executive Office is Executive Secretary of the conference.

New hydro giant proposed

Los Angeles Department of Water and Power has filed plans with the Federal Power Commission for a $1.1-billion hydroelectric project on the Colorado River. The Marble Canyon-Kanab Creek project will be north of the Grand Canyon National Park, about 200 miles upstream from Hoover Dam. It contemplates driving a record-breaking 43-mile tunnel from a small power plant at Marble Canyon to a 2-million-kw capacity underground power plant at Kanab Creek. The plan suggests Federal sponsorship, with the contracting agencies of Arizona, California and Nevada repaying all costs of the government investment. Arizona would get about 2-billion kwhr, California and Nevada about 5.3-billion kwhr annually. If acted on, the plan would displace an Arizona application for a Marble Canyon development, but not L.A.'s plan for development at Bridge Canyon.

Water bullets pierce metals

Westinghouse scientists shoot bullets of water traveling 3400 mph to penetrate thin pieces of metal. Primary aim: understand the wet-steam erosion of turbine blades at the exhaust end. A small lead pellet is fired down a 30-in. metal tube by 150-psig gas. Pellet strikes a sealed water reservoir with a tiny opening aimed at metal sample. On impact, water jet is squeezed out, striking the metal. A high-speed camera records jet and metal action at exposures as short as five millionths of a second. One unexpected finding: a brilliant flash of light shows at moment of impact. It lasts about one-millionth of a second—reason for it is unknown as yet.

Results of the bullet experiments: (a) water jets create craters with profiles similar to those produced by meteorites crashing into the earth (b) Stellite and tungsten carbide show greatest resistance to water erosion (c) uniform jets with smooth leading face cause more damage than irregularly shaped ones (d) metal-surface irregularities have little effect on erosion damage (e) thin films of water or oil don't protect metal's surface (f) visible damage seems to correspond to actual threshold of water erosion found in steam-turbine blades.

Metered air conditioning

Rebuilt LaGuardia airport in New York City is getting a metered air-conditioning system. Automatic-sensing equipment adjusts the amount of cooling water delivered to each area. Chilled water at constant 44 F will be pumped into the units and meters will register temperature of water leaving each unit to fix the cooling load. Four Carrier refrigerators will cool 5240 gpm of water from 57 to 44 F for a total cooling capacity of 2728 tons. System starts running in spring of 1962.

Electricity from ocean waves

Central electricity board of Mauritius in the Indian Ocean proposes a 44-mw power plant to generate electricity from ocean waves. Most of the year, rollers 4- to 12-ft high break on the island's southern- and eastern-coast coral reefs. At Souillac the coral reef almost encloses a shallow lagoon that drains at low tide. Enclosing the lagoon completely would turn it into a reservoir, refilled by the breakers. Slight tidal movement makes it possible to use the head of water to run low-head turbines. Tests carried out at the Hydraulics Research Station in England show that ramps to guide the waves into the lagoon should have a fixed crest matching most prevalent waves at the site. Wave height and frequency are being measured at the lagoon, as first step in the economic study of the project. (*McGraw-Hill World News*)

Transformer uses supercold

Dr R McFee of Arthur D Little, Inc has developed a new transformer that has run successfully at 15 kw. This transformer could lead to lighter and cheaper units with small power loss, posing no temperature-limitation problem for insulation. The unit uses superconductivity of the metal windings by lowering temperature near absolute zero (–459.6

this month's power-field happenings

B G A SKROTZKI, Associate Editor

F). Interleaving layers of primary and secondary windings keeps total magnetic-field strength down—if allowed to reach a critical level, it could quench the field created by the continuous current maintained by the superconductivity. The Gifford-McMahon helium refrigerator, running unattended, can hold the windings at –452 F for months. Only the superconducting coils are cooled; transformer core stays at room temperature. Vacuum insulation, liquid-nitrogen heat shields and specially designed input leads keep heat leakage at a minimum.

Computer goes to work

Bergen Station of Public Service Electric and Gas Company now has a performance computer at work to monitor its two 290-mw units. The transistorized digital computer, developed by Leeds & Northrup Company and Philco Corporation, gets data from 196 measuring devices in the plant. It calculates and displays 16 operating guides needed to run the plant at maximum efficiency. The computer prints out—hourly, daily, weekly and monthly—comprehensive calculations and reports detailing boiler and turbine performance. By pushbutton command it will type out 50 operating values.

Test line energized at 775 kv

An extra-high-voltage test transmission line at Apple Grove, W. Va. was energized at 775 kv, highest in the U. S. and probably in the world. This marks the start of a 5-yr program by American Electric Power Service Corporation and Westinghouse Electric Corporation to work out new high-voltage practices. Project will develop data on corona loss and radio-influence performance of conductors at 750 kv to find the technical and economic feasibility of EHV transmission. Test line's three 2400-ft 3-phase legs form a tee.

Dams in China

U.S. will loan Nationalist China $44 million to build a multipurpose dam and hydro plant at Tachien Reservoir on Taiwan. Loan will provide about three-fourths of the foreign-exchange costs of the project. Construction includes a 778-ft-high dam and an auxiliary rock-fill dam 460-ft high. The plant will have 1214-mw capacity and the reservoir will irrigate about 115,000 acres. U.S. contracting firms will build the dams and procure material and equipment in the U.S. (*McGraw-Hill World News*)

New superpressure unit

Public Service Electric and Gas Company is installing a 400-mw superpressure unit in its Hudson Station at Jersey City, N.J. The unit will run at 3625 psig and 1000/1025/1050 F and is scheduled to start in early 1965. A B&W Universal Pressure boiler will supply 2.45-million lb of steam per hr and be cyclone-furnace fired.

Gigantic power potential

Brazil's Mining and Power Minister has named a group to study construction of a hydroelectric project at Sete Quedas, one of the world's greatest waterfalls, on the Parana River between the Brazilian state of Parana and Paraguay. Total potential of the seven falls is estimated at 100-million kw. Sete Quedas is about 200 miles downstream from the 3-million-kw Urubupunga project which six Brazilian states are undertaking with the help of international financing. (*McGraw-Hill World News*)

Red turbine to Cuba

Trade between U.S.S.R. and Cuba includes a 50-mw steam turbine. Unit will run at 1280 psig and 995 F. Actual building of unit, in the U.S.S.R.'s Charkov plant, will start immediately. Shipment is scheduled for late 1961.

Expenditures for R&D

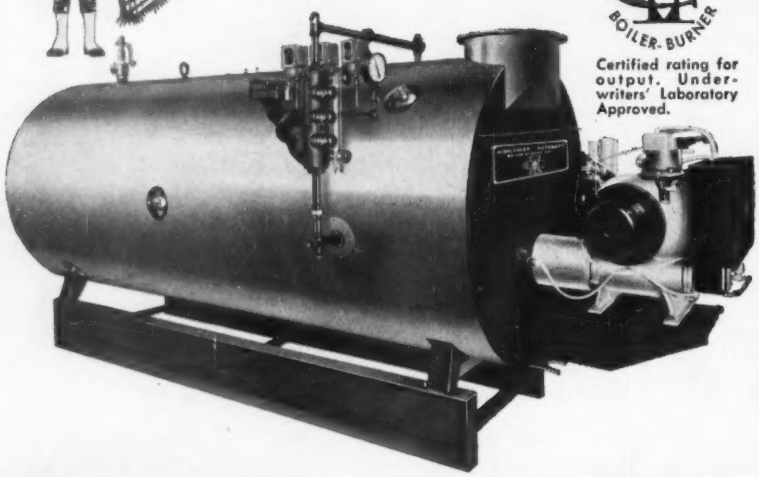
Colleges and universities spent $154 million during 1958 for research and development facilities in the natural and social sciences, according to a National Science Foundation survey. About $112 million (or three-fourths) came from non-Federal sources—the institution's own funds, State appropriations or private endowments—with the Federal Government contributing the remaining $41 million. Federal support was largely confined to college and university research centers which are Federal-administered. Life sciences received 50% of total expenditures; physical, 33%; engineering, 15% and social sciences, 3%.

Record geothermal output

Geysers Power Plant of Pacific Gas & Electric Company generated a record 8658 mwhr in May. PG&E paid a record $21,645 for the geothermal steam to its producers, the Magma and Thermal Power Companies.

continued

NEW
HIGHLANDER
COMPLETELY AUTOMATIC BOILER-BURNER UNIT



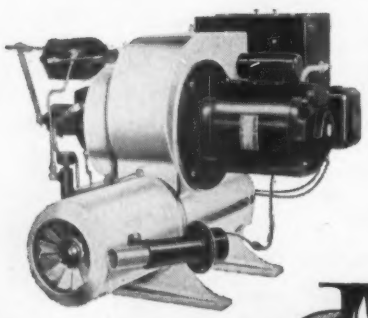
Certified rating for output. Underwriters' Laboratory Approved.

PROVEN ECONOMY

SAVES ON INSTALLATION. The new Highlander is a completely assembled boiler-burner plant. Installing one simple unit saves money. Designed by Engineers with years of experience in matching burners and boilers for the exact job—whether it is power, processing or heating. No problem of taking a boiler and trying to match a burner to it. The Highlander Boiler-Burner unit is design-controlled at the factory.

SAVES ON OPERATION. Designed to get maximum economy from available fuels. The Highlander is built for low pressure or high pressure steam or hot water — Industrial Combustion burner furnished for a heavy oil, light oil or combination of gas/light or gas/heavy oil. Simple! Just 2 flue passes. Easy Maintenance! Boiler interior easily accessible. Reliable! Each burner is completely fire tested at the factory.

YOUR CHOICE OF HEV-E-OIL, HEV-E-DUTY GAS or COMBINATION GAS and OIL BURNER



HEART OF THE HIGHLANDER is the famous Industrial Combustion Burner. The HEV-E-OIL Burner engineered to use inexpensive No. 4, 5 and 6 heavy oils is shown here. Available from 5 to 150 gph. HEV-E-DUTY Power Gas Burners and Combination gas/oil Burners from 720,000 to 21,000,000 BTU.

Write Dept. J-81 for complete information.

INDUSTRIAL COMBUSTION INC.

EXECUTIVE OFFICES: 4447 N. OAKLAND AVE., MILWAUKEE 11, WIS.

For more facts circle 309 on Reader Service card, p 107

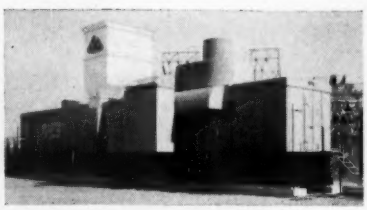
Powerscope

Begins on page 160

PG&E plans to double The Geysers Geothermal Power Plant. The plant, which generates electricity with natural steam brought from within the earth, began operation last summer (POWER, July '60, pp 80 to 82). A 12,500-kw $2.2-million generating unit will be added to one that size already in service.

Four of the seven steam wells developed supply the present unit. Installation of the new unit will complete the plant's generating facilities. However, the Magma and Thermal Power Companies are investigating steam supplies for possible development in nearby areas along the Big Sulphur Creek. At present 10 of 3000 acres have been developed.

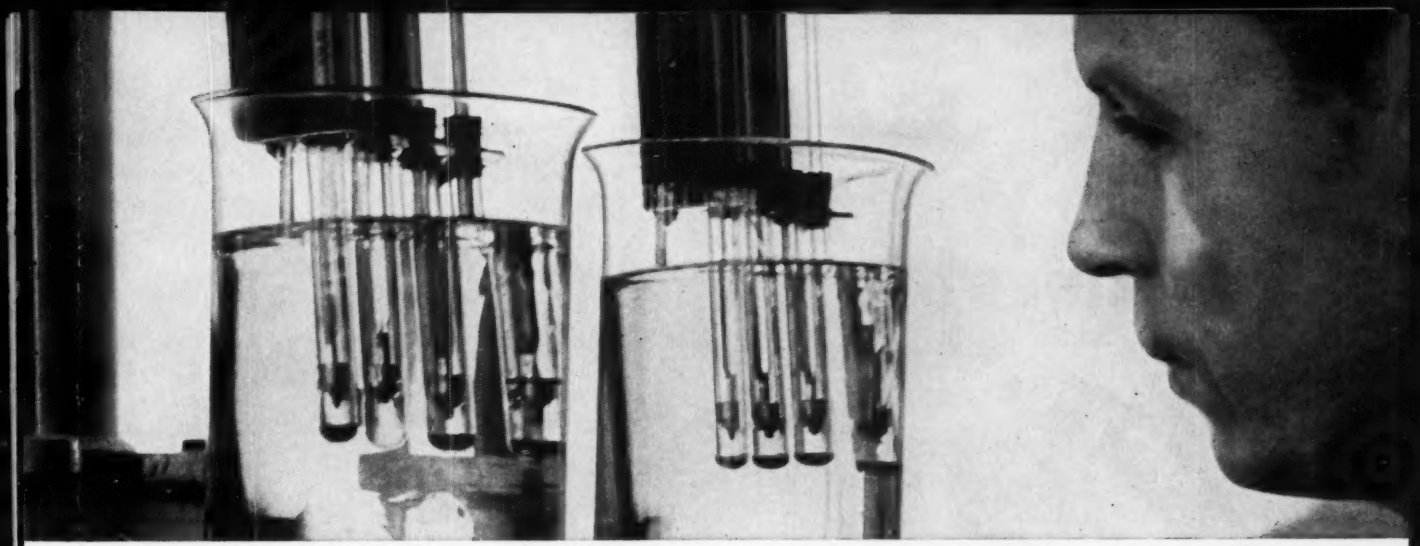
Geothermal projects are possible only where the magma—the molten mass ordinarily deep within the earth—is close to the surface. Steam formed from water in the magma is emitted through underground fissures. Then surface water seeping down contacts the heated rock, forming even more steam. At the plant, they've drilled 500 to 700 ft to reach and free the steam. Then it's piped to the electric - power - generating station's turbines.



Packaged g-t plant: an electrical "first"

Several hundred utility and industrial customers witnessed operation of the nation's first gas-turbine packaged power plant. Plant was designed by General Electric Company's Gas Turbine Dept to provide a low-cost remote-controlled unattended power source (POWER, Feb 1961, pp 82-3). Representatives saw operation of a complete plant—from concrete slab to remote control. Setup duplicated operating conditions on their own systems. Following the 3-day demonstration, unit was shipped to South Carolina Electric & Gas Company which purchased four of the 11,250-kw units.

continued



Dropping point test shows how greases react to heat. Beaker fluid has been heated to 390°F. All greases tested except Darina (second tube from let) have passed from solid to liquid state.

BULLETIN:

Shell reveals the remarkable new component in Darina Grease that helps it save up to 35% on grease and labor costs

Darina® Grease is made with Microgel*, the new thickening agent developed by Shell Research.

Darina lubricates effectively at temperatures 100° hotter than most conventional soap base greases can withstand.

Read how this new multi-purpose industrial grease can help solve your lubricating problems and even save you up to 35% on grease and labor costs.

THERE IS no soap in Darina Grease. No soap to melt away—wash away—or dissolve away.

Instead of soap, Darina uses Microgel—a grease component developed by Shell Research.

What Microgel does

Because of Microgel, Darina has no melting point. It won't run out of gears or bearings.

Compared with most conventional soap-base greases, Darina provides significantly greater protection under adverse service conditions.

Mix water into Darina and the grease does not soften. It shrugs off water—won't emulsify.

Resists heat

Darina will withstand operating temperatures 100° hotter than most conventional multi-purpose greases. It cuts leakage and reduces the need for special high-temperature greases.

Also, Darina resists slumping, thus forming a more effective seal against foreign matter.

Saves money

Shell Darina can reduce maintenance expenses while it protects your machinery. Savings of up to 35% on grease and labor are quite possible.

In some cases lubrication intervals have been extended to double what they were before. Less grease is consumed and less time consumed applying it.

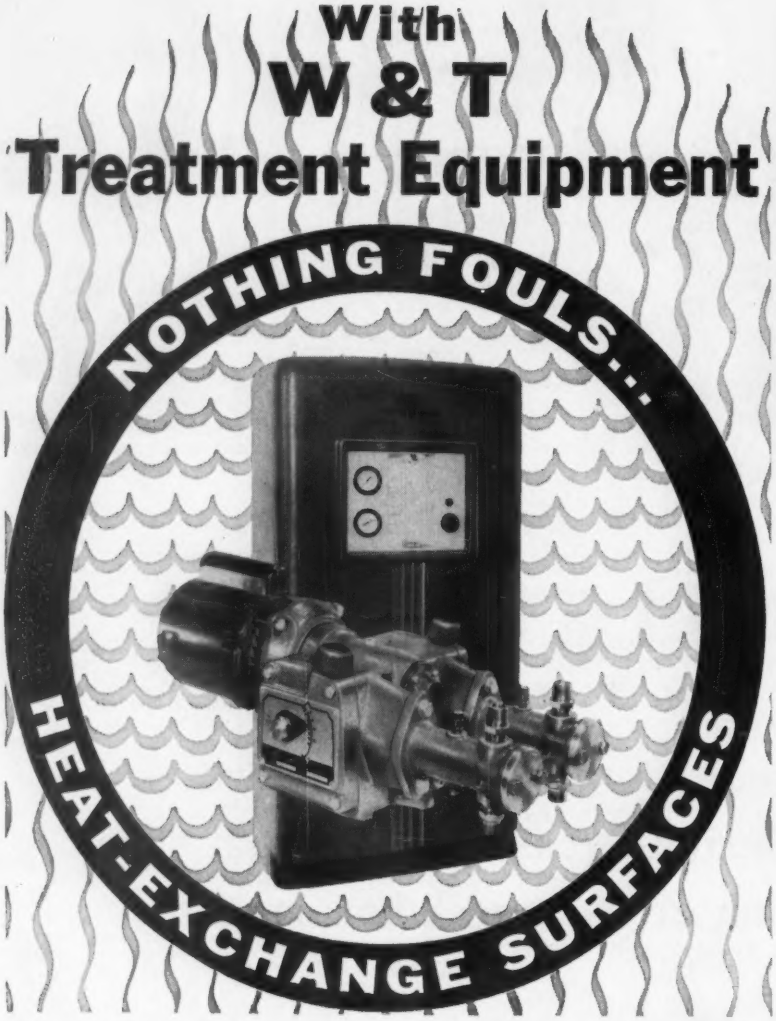
For details, see your Shell Representative. Or write: Shell Oil Company, 50 West 50th Street, New York 20, New York.

*Registered Trademark

SHELL

A BULLETIN FROM SHELL
—where 1,997 scientists are helping to provide better products for industry

With
W & T
Treatment Equipment



Now you can take the sting out of cooling-water contaminants, solve treatment problems with chlorinators and pumps by Wallace & Tiernan.

For biological control there's intermittent desliming.

W&T chlorination kills slime and spores, never lets growth affect heat-exchange capacity. Job-proportioned V-notch Chlorinators feed up to 8,000 lbs. of chlorine per day. Treatment is efficient and economical. You get reliable control. Heat-exchange surfaces stay slime-free.

For pH and corrosion control there's chemical feeding.

The Wallace & Tiernan Series 100 Pump feeds chromates or acids at rates of up to 50 gph or boiler-treatment chemicals against pressures up to 1200 psi. The pump's unitized construction means lifelong accuracy, reduced maintenance. Choose one or two liquid ends, with individual stroke adjustment, to double capacity or feed two chemicals simultaneously. Where high pressures are not a problem, W&T Diaphragm Pumps also give reliable feeding of 1 to 500 gpd. Heat-exchange surfaces stay corrosion-free.

With Wallace & Tiernan Chlorinators and Pumps you keep condenser tubes clean and sound, assure heat-exchange efficiency.

For more information, write Dept. S-149.76.

WALLACE & TIERNAN INC.
25 MAIN STREET, BELLEVILLE 9, NEW JERSEY

For more facts circle 311 on Reader Service card, p 107

Powerscope

Begins on page 160

Plant is rated for peak service at NEMA conditions—80 F and 1000-ft altitude. It is suitable for –40 to +120 F operation. Packaged concept means less than 5% of total station cost will go for site, labor and installation materials. Erection is quick; plant can be installed and placed in commercial service in about ten days. If station need be moved, less than 5% of initial investment is left behind.

Thermoelectric generator goes to Sweden

A 100-w thermoelectric generator will be supplied to the Swedish army by Westinghouse Electric International Company. Propane gas fuels the generator. Heat from the gas flame produces a flow of current when applied to junctions of two different semiconductor materials. Air-cooled 40-lb unit can run unattended for months.

Dispatching system ties together three plants

Southwestern Public Service Company will use a General Electric Company automatic dispatching system to control six of its turbine-generators in Texas and New Mexico. The system, costing nearly $100,000, should be completed at the end of this year. It ties together Plant X with three turbine-generators, Cunningham Station with one, and two turbine-generators at Nichols Station.

Southwestern will feed the equipment data of what's going on at its other generating plants.

New hydro plant will be automated

California Oregon Power Company's new 18,000-kw hydroelectric generating plant will be located on the Klamath River in California. Generator for the Iron Gate plant will be rated 18,947 kva. Iron Gate will be a completely self-contained automatic station controlled from an existing plant several miles away.

circle 312 on Reader Service card, p 107 ➤

The more fittings, the more time saved with Armstrong Armaflex 22

Armaflex 22 is a great time-saver on pipe covering jobs, and the more fittings there are, the more time it saves. Insulating fittings with conventional materials is messy and time-consuming work, but making fitting covers out of vaporproof Armaflex is simple and fast. Pieces are miter-cut, joined with adhesive, snapped in place, and joints sealed.

Armaflex 22 is part of a complete line of insulation products which prevent condensation and retard heat loss or gain on jobs from below zero to 220F. Also available are Rigid Armaflex for areas where insulation compression is a problem, Armaflex Sheets for tanks, large pipes and fittings, and Armaflex Adhesives and Finishes.

For your copy of the Armaflex Specifier Portfolio, which contains complete data on the products in the complete Armaflex line, plus detailed specifications on their application, write today on your company letterhead to Armstrong Cork Company, 2208 Riggs Avenue, Lancaster, Pennsylvania.

Armstrong INSULATIONS

VOTE HERE

what use can you make of this

DIAPHRAGM VALVE?

Check one or more of the following

- ☐ As a power-operated line valve of any kind, normally-open or normally-closed, with better-than-average low pressure-loss and high flow-rate characteristics.
- ☐ As a remotely-operated flow-control valve in an inaccessible location where reliability and long life are important.
- ☐ As automatically-controlled units in a complexity of flow circuits, where rapid and certain response to control signals is significant.
- ☐ As a large power-operated control valve where the actuating power is the actual line pressure, and release is accomplished by simply bleeding this pressure to drain with a small solenoid, pneumatic, or manual valve.

INSTRUCTIONS

1. After "voting," write your name, company, and address in the margin.
2. Tear out this Ad and mail to:

AquaMatic INC.

2402 GRANT AVE., ROCKFORD, ILLINOIS

ENGINEERED WATER AquaMatic CONDITIONING CONTROLS

circle 313 on Reader Service card

Calendar

Aug 21-31—United Nations Conference on New Sources of Energy, Food and Agriculture Organization headquarters, Rome, Italy. Details: A G Katzin, Office of Public Information, United Nations, N. Y.

Aug 23-25 — 4th Biennial Gas Dynamics Symposium, sponsored by American Rocket Society and Northwestern U, at Northwestern. Details: Mechanical Engineering Dept, Northwestern U, Evanston, Ill.

Aug 23-25—American Institute of Electrical Engineers, Pacific General Meeting, Hotel Utah, Salt Lake City. Details: AIEE, 33 W 39th St, New York 18, N. Y.

Aug 28-Sept 1 — International Heat Transfer Conference, U of Col., Boulder, Col. Details: ASME, Meetings Dept, 29 W 39th St, New York 18, N. Y.

Aug 30-Sept 1—American Institute of Mining, Metallurgical and Petroleum Engineers, 3rd Annual Semiconductor Conference, Ambassador Hotel, Los Angeles, Calif. Details: AIME, 29 W 39th St, New York 18, N. Y.

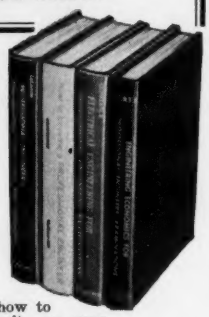
Sept 3-8 — American Chemical Society, National Meeting, Chicago, Ill. Details: R Avery, ACS, 2 Park Ave, New York 16, N. Y.

Sept 6-8—Joint Nuclear Instrumentation Symposium, sponsored by ISA, AIEE, IRE, N. C. State College, Raleigh, N. C. Details: Meetings Manager, ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

Sept 11-15—Instrument Society of America, Fall Instrument-Automation Conference & Exhibit, 16th Annual Meeting, Memorial Sports Arena, Los Angeles, Calif. Details: Meetings Manager, ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

Sept 14-15 — Engineering Management Conference, American Society of Mechanical Engineers, American Institute of Electrical Engineers, Hotel Roosevelt, New York,

Which of these 3 libraries will help you *earn more?*



1. PROFESSIONAL ENGINEER'S LICENSE EXAMINATION LIBRARY

4 volumes, 1585 pages, 734 illustrations, $29.00
EASY TERMS

Tells you where and how to apply . . . how to write up your experience . . . the kind of questions you will be asked and the type of answers that get full credit. Covers mechanical, electrical, civil, structural, and chemical engineering, economics, and surveying.

2. PLANT OPERATORS' AND STATIONARY ENGINEERS' LIBRARY

5 volumes, 2411 pages, 1723 illustrations, $26.95
EASY TERMS

Brings you a vast amount of practical data to help you install, operate, and service machinery and equipment vital to plant operation. Pumps, steam and gas turbines, a-c and d-c electric machines, boilers—every step in their safe and efficient operation is made plain by experts. A special volume gives you a concise review of mathematics essential to men in practical jobs. Use the Library for increased production and power output . . . reduced maintenance and repair time.

3. ELECTRIC UTILITY POWER LIBRARY

4 volumes, 1730 pages, 1158 illustrations, $29.95
EASY TERMS

Top engineers in the field carefully explain every step in electrical generation in this library. They show you the workings of entire steam, hydro, and diesel stations, as well as gas-turbine plants . . . answer all your questions about transmission and distribution systems. In addition, the Library shows you how to handle each of the operations involved in scheduling and maintaining equipment to produce efficient and economical power. It treats boiler control—load dispatching—rate schedules—control of circuit breakers—how fuel is selected—and more.

SEE ANY LIBRARY 10 DAYS FREE

McGRAW-HILL BOOK CO., DEPT. P-8
327 W. 41st St., N.Y.C. 36, N.Y.

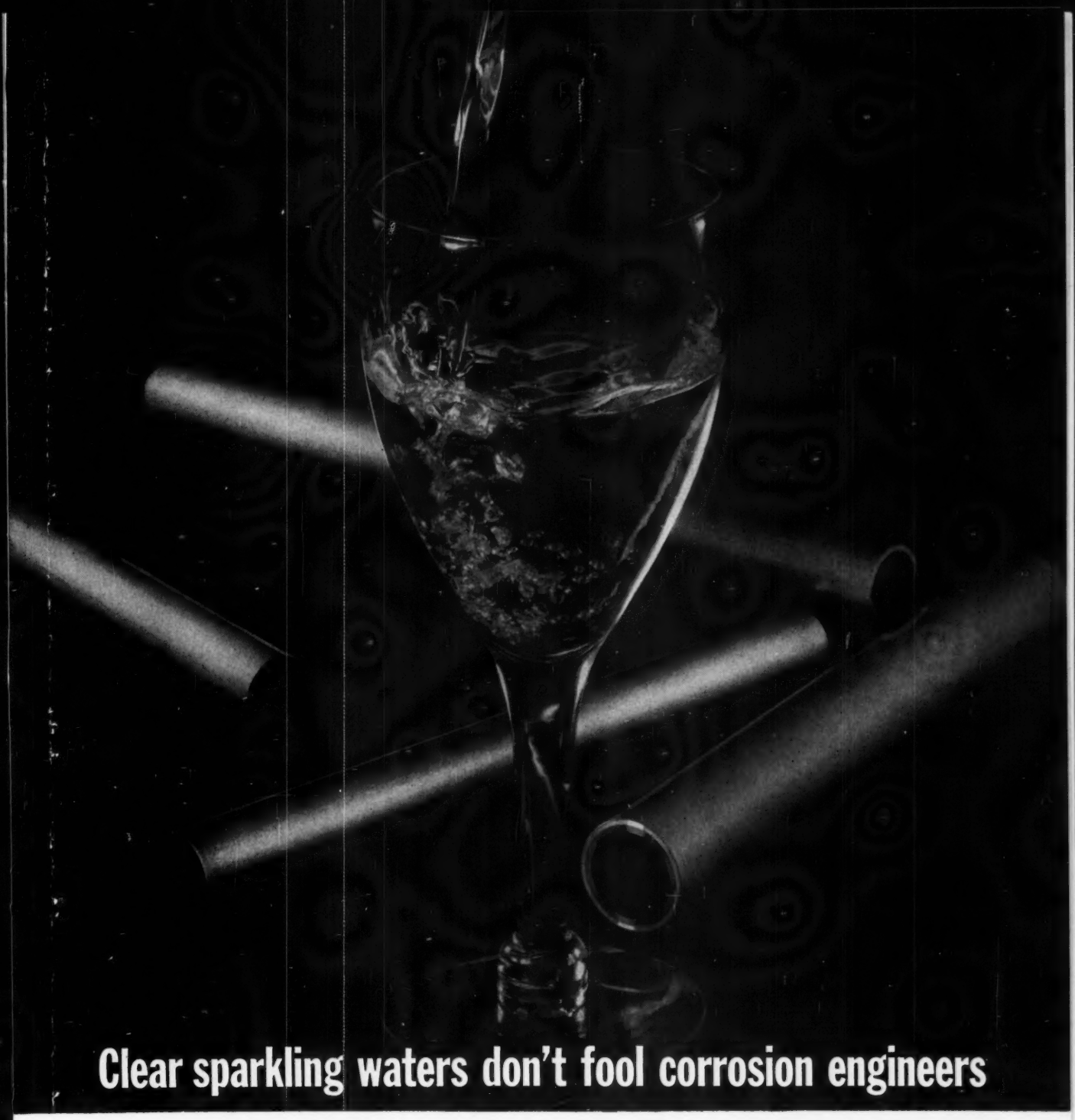
Send me the libraries checked below for 10 days' examination on approval. If satisfied, I will send (check one) ☐ full price, or ☐ initial payment followed by monthly payments, according to terms indicated for each library below. Otherwise I will return books postpaid.

- ☐ #1—I will pay $9 in 10 days, and $10 monthly until $29.00 is paid
- ☐ #2—I will pay $6.95 in 10 days, and $5 monthly until $26.95 is paid
- ☐ #3—I will pay $4.95 in 10 days, and $5 monthly until $29.95 is paid

(Print)
Name .....
Address .....
City & Zone ..... State .....
Position .....
Company .....

For prices and terms outside U.S., write McGraw-Hill Intl., NYC 36 P-8

circle 314 on Reader Service card



Clear sparkling waters don't fool corrosion engineers

Coupled with temperature, pressure and velocity, some waters can chew up condenser tubes faster than you would believe possible. Minute differences in oxygen, chemical or biological content give each a corrosive character of its own that calls for well-informed tube alloy selection.

Case histories in which tube life has been increased from months to *years*—or from years to many *more* years—are packed in Bridgeport's files. The training and experience of our corrosion specialists can help match the best tube alloy to your water supply—whether potable, saline, brackish or polluted.

Write for information on Bridgeport's regular or Duplex tubes—or call in a Bridgeport man for quick and practical assistance on your corrosion, erosion or bio-fouling problems.

Bridgeport condenser and heat exchanger tubes in over 50 metals and alloys:

INHIBITED ADMIRALTY
INHIBITED ALUMINUM BRASS
INHIBITED MUNTZ METAL
70-30 CUPRO NICKEL
90-10 CUPRO NICKEL
DEOXIDIZED ARSENICAL COPPER
INHIBITED ALUMINUM BRONZE
RED BRASS
ALLOY 77 MERCURY BRASS

...plus **DUPLEX TUBES**...in combinations of the above alloys, with carbon or stainless steel, aluminum, Monel,® nickel...or other metals.

BRIDGEPORT BRASS COMPANY

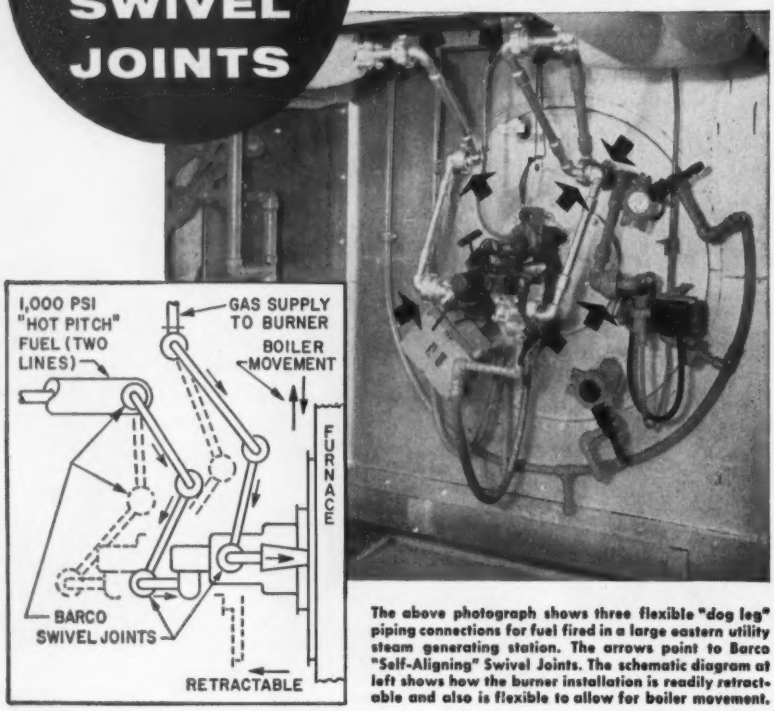
Bridgeport 2, Connecticut

Bridgeport

For more facts circle 315 on Reader Service card, p 107

-Installs
BARCO
Self-Aligning
SWIVEL
JOINTS

SAFETY
for Burners
handling 450° Fuel
at 1,000 psi



The above photograph shows three flexible "dog leg" piping connections for fuel fired in a large eastern utility steam generating station. The arrows point to Barco "Self-Aligning" Swivel Joints. The schematic diagram at left shows how the burner installation is readily retractable and also is flexible to allow for boiler movement.

Power Plant Uses Steel Pipe for "Flexible Connections"

THE idea of using steel pipe, instead of hose, appeals to many engineers—especially where fuel is being handled at high temperature and pressure.

In the boiler plant shown above, heavy pitch, obtained from a nearby oil refinery, is pre-heated to 450°—500°F and pumped at 1,000 psi to the burners of the steam generators. On each burner, two 1″ lines feed hot pitch; a third 1½″ line (painted gray) handles natural gas for auxiliary firing.

Each line is fitted with three Barco Type S All-Steel Swivel Joints with welded connections. Periodically, all lines are purged with 150 psi steam.

With a total of 642 Barco joints installed, only one joint has required any maintenance in two years of service. One of the big advantages of these joints is that they have NO BALL BEARINGS. They don't bake dry at high temperatures. NO LUBRICATION REQUIRED. Another big advantage is that they are *self-aligning;* this eliminates binding and simplifies and speeds up pipe fitting. For detailed information, ASK FOR CATALOG 265D.

BARCO
MANUFACTURING CO.
522J Hough Street, Barrington, Illinois
The Only Truly Complete Line of Flexible Ball, Swivel, Swing and Rotary Joints
In Canada: The Holden Co., Ltd., Montreal
For more facts circle 316 on Reader Service card, p 107

Calendar

Begins on page 166

N. Y. Details: ASME, 29 W 39th St, New York 18, N. Y.

Sept 21-22 — Industrial Electronics Symposium, sponsored by AIEE, IRE, ISA, Bradford Hotel, Boston, Mass. Details: AIEE, 33 W 39th St, New York 18, N. Y.

Sept 24-27—American Institute of Chemical Engineers, Meeting, Lake Placid Club, Lake Placid, N. Y. Details: AIChE, 25 W 45th St, New York 36, N. Y.

Sept 24-29—Illuminating Engineering Society, National Conference, Chase Park Plaza Hotel, St. Louis, Mo. Details: A D Hinckley, IES, 1860 Broadway, New York 23, N. Y.

Sept 25-28—Industrial Building Exposition & Congress, New York Coliseum. Details: Clapp & Poliak, Inc, 341 Madison Ave, New York 17, N. Y.

Sept 26-28—6th Annual Sanitation Maintenance Show, Sheraton Hotel, Philadelphia, Pa. Details: L S Rogers, 310 Lexington Ave, New York 16, N. Y.

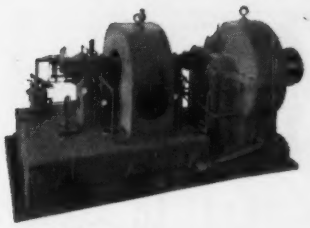
Oct 1-5—Electrochemical Society, Inc, Meeting, Statler Hotel, Detroit, Mich. Details: Electrochemical Society, Inc, 1860 Broadway, New York 23, N. Y.

Oct 3-6—9th Annual Human Engineering Institute, Stamford, Conn. Details: Dunlap and Associates, Inc, 429 Atlantic St, Stamford, Conn.

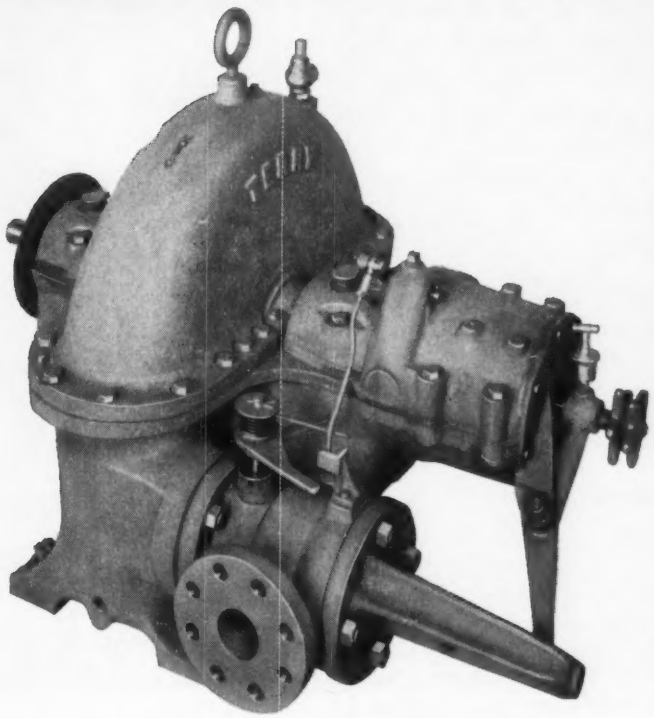
Oct 4-6—Solid Fuels Conference, cosponsored by ASME Fuels Div, AIME Coal Div, Dinkler Tutwiler Hotel, Birmingham, Ala. Details: ASME Fuels Div, 1300 Leader Bldg, Cleveland 14, Ohio.

Oct 10-12—Oak Ridge National Laboratory, Nuclear Reactor Chemistry and Analytical Chemistry in Nuclear Reactor Technology Conferences, Gatlinburg, Tenn. Details: Oak Ridge National Lab, P O Box X, Oak Ridge, Tenn.

There's a Terry solid-wheel turbine for any mechanical-drive requirement



Solid-wheel turbo-geared unit rated 600 hp, 4000/650 rpm.



Standard solid-wheel turbine with constant-speed mechanical-type governor and hand speed changer.

The completeness of the Terry line of solid-wheel turbines enables you to choose an *ideal* drive for any application . . . choose the specific features you want from a wide variety of designs.

Standard turbines are made in capacities up to 2,500 hp, with either cast-iron or cast-steel casings. The standard wheel is carbon steel. Where operation is to be at high speed or at high temperature, wheels of forged alloy steel are used. Vertical and geared turbines are also available.

And you can select from a range of governors, including: constant speed, either mechanical or oil relay, and variable speed, either direct acting or oil relay. Excess-pressure or constant-pressure pump governors are also available. When required, remote speed control can be furnished for variable-speed governors.

Tell us what your requirements are so we can send you full details of a turbine to meet your needs exactly. For general information, send for a copy of bulletin S-116.

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD 1, CONN.

TERRY

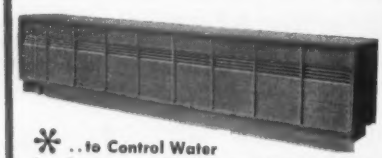
Vertical turbines with the Terry solid wheel are available in capacities from 5 to 300 hp.

TT-1218

MURCO GATE HOISTS

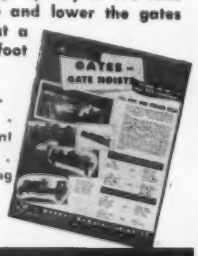
designed to meet your requirements for any size power dam ...

* One of the two 380-ton MURCO Gate Hoists furnished to the Power Authority of the State of New York. Each hoist operates a gate 46' wide by 67' high at one foot per minute. These gates divert the water from the Niagara River above the Falls into covered conduits five miles long. The two conduits bring the water to the Niagara Generating Plant on the United States side of the Falls.



* ..to Control Water Level at Long Sault Dam, St. Lawrence Power Project . . . illustrated is one of the 18 MURCO Gate Hoists installed in this project.

For the second largest hydroelectric power plant in the United States at Massena, New York — as part of the St. Lawrence power project — Uhl, Hall & Rich, project engineers, selected MURCO Gate Hoists. Each hoist weighs 93,000 lbs. . . . overall length 57 feet, 8½ feet wide, 12½ feet high . . . lifting capacity of 175 tons and will raise and lower the gates in the dam at a speed of 1 foot per minute.



Write for complete information . . . Engineering Department recommendations . . . when you are planning power dam projects.

D. J. MURRAY MANUFACTURING CO.

MANUFACTURERS SINCE 1883 • WAUSAU, WISCONSIN

circle 318 on Reader Service card, p 107

Appointments

Awards

Dr John G Trump

American Institute of Electrical Engineers has awarded the Lamme Gold Medal to Dr John G Trump, professor of electrical engineering at the Massachusetts Institute of Technology, during its summer meeting at Cornell University. Dr Trump was cited for invention and design related to multielectrode acceleration tubes and Van de Graaf generators. Prominent in cancer-treatment research, he designed one of the first million-volt X-ray generators used in cancer therapy.

Consultants

Engineers Inc: acquired the firm of Julius Berger, ME. **Chas T Main, Inc:** C A Dauber, head of thermal power engineering. **Commonwealth Services Inc:** H C Wyland, vice-president.

New names

Smith Thermotronics, Inc: new name for E C Smith Mfg Co. **Pyronics, Inc:** name change for Bryant Industrial Products Corp. **Kamweld Products Company:** new name adopted by Kamlar Products Co. **Watubo Industries:** new corporate name for Water Tube Boiler & Tank Co. **Rochester Instrument Systems, Inc:** new designer and manufacturer of electronic systems, especially nuclear-reactor instrumentation. **Aqua-Chem, Inc:** new name for Cleaver-Brooks Special Products Co.

General managers

Indiana General Corp, Stearns Magnetic Products Div: H W Buus. **General Electric Co,** Silicone Products Dept: J H Blomshield, facilities design and construction. **Diamond Power Specialty Corp,** Electronics Div: E R Heath, Applied Electron Physics. **Alpha-Molykote Corp:** J R Jones, new-product development. **Electric Storage Battery Co,** Nickel-Alkaline Battery Div: W W Smith, engineering and development.

Eaton Mfg Co, Automotive Gear

Write for....

Power's

REPRINT FOLDER

....which gives

SUMMARIES and PRICES on

Power's

information-packed

SPECIAL REPORTS

"the most useful condensed handbooks in the field."

POWER, 330 West 42nd St.
New York 36, N. Y.

Please send me a copy of POWER's "REPRINT FOLDER"

Name .....

Address .....

City & State .....

SARAN LINED PIPE—strong enough, inert enough for atomic power plant system

Almost 2,000 feet of Saran Lined Pipe, fittings and valves will carry non-radioactive acid solutions and sodium hypochlorite at Indian Point Station, N. Y., Consolidated Edison Company's atomic power plant.

Saran Lined Pipe has the combination of chemical resistance and structural strength which severe service conditions of this type require, and it has been estimated that Saran Lined Pipe may give as long as 25 years of trouble-free service.

At Indian Point Station, Saran Lined Pipe was installed by an independent engineering firm. Project engineers point out that another advantage of this corrosion-resistant piping system is its ease and economy of installation. Crews easily cut and fit pipe without expensive prefabrication, without breakage, and using standard tools and equipment.

Saran Lined Pipe, fittings, valves and pumps are available for systems operating from vacuum to 300 psi, from below zero to 200°F. They can be cut, fitted and modified easily in the field without special equipment. For more information, write Saran Lined Pipe Company, 2415 Burdette Avenue, Ferndale, Michigan, Dept. 1573DW8.

THE DOW CHEMICAL COMPANY DOW Midland, Michigan

YOU GET EVERYTHING THE ENGINEER & MAINTENANCE MAN ASKED FOR IN THIS NEW LIGHT WEIGHT, COMBINATION STEAM TRAP!

Fast warm up through rapid removal of both air and condensate up to 10° F. of saturation.

●

Continued discharge of air and condensate at steam temperature.

●

Built-in filtration of solids

●

Easy access to all working parts

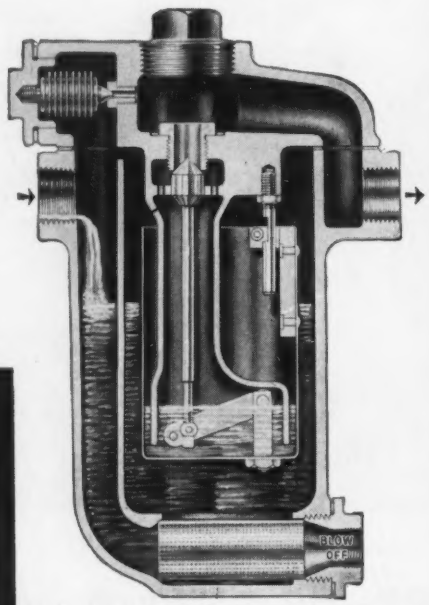
●

Interchangeable main orifice

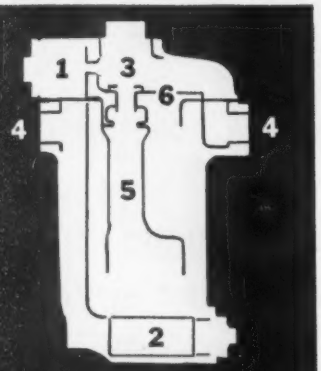
●

Light enough to be supported by line

Step by step steam traps have been improved, making them compact, lighter and more efficient, easier and faster to service. Now Wright-Austin has incorporated all these advances into one of their proven vertical bucket-type traps—the new 500-C series. Write for literature.



500-C Series—For ½" to 2" pipe lines; Pressures to 150 PSIG; Capacity to 30,000 lbs./hr.



1. Monel thermostat air by-pass
2. Monel strainer
3. Valve seat accessible through inspection plug
4. Straight-through pipe connections
5. All operating parts stainless steel
6. Working parts removed with cover

For fast and continuous heat in:

Unit heaters
Hot water heaters
Steam mains
Laundry equipment
Platen presses
Heat exchangers
Cylinder dryers
Jacketed Kettles
Sterilizers
Evaporators

WA 1894 **WRIGHT-AUSTIN COMPANY**
3245 WIGHT STREET • DETROIT 7, MICH.

Export Dept., 8 South Michigan Ave., Chicago 3, Ill.

For more facts circle 321 on Reader Service card, p 107

Appointments

Begins on page 170

Div: R C Jacobs. **Tube Distributors Co Inc,** Special Products Div: J P Barrett. **Byron Jackson Pumps, Inc,** Foreign Operations Dept: R Bibolini. **Minneapolis-Honeywell Regulator Co,** Heiland Div: W D Owens. **Fischer & Porter Co,** International Div: J J Quintero. **General Electric Co,** Electric Utility Engineering Operation: C F Schaus, Industrial Appearance Design. **Alco Products, Inc:** W J Stromquist, SM-1 nuclear plant.

Obituaries

Oscar H Jung, founder and president of Trico Fuse Mfg Co, on May 5, at the age of 76.

Gordon Murphy, vice-president of Foote Bros Gear & Machine Corp and The Whitney Chain Co, on April 26. He was 49.

Dr Ralph E Hall

Hagan Chemicals & Controls, Inc lost their director emeritus when Dr R E Hall died on May 2. He was 76. Dr Hall founded Hall Laboratories, industrial-water-consulting firm and a Hagan division. He received 54 patents and authored more than 60 papers in the field of physical chemistry, and was the discover of Calgon, a boiler-water treatment agent.

In 1953 he received the Lamme Medal from Ohio State University; in 1940 the Modern Pioneer Award from the National Association of Manufacturers.

ROBVON
BACKING RINGS
SIMPLIFY
PIPE WELDING IN ADVERSE FIELD CONDITIONS
FAST•EASY•FIT-UPS

TYPE CCC

Designed for quick easy alignment of pipe where the variation in inside diameters is relatively great. Chamfered NUBS allow close tolerance fit-up and CLEAN STRIKE OFF. The ROBVON NUB automatically sets root gap. ROBVON rings are beveled to assure non-restricted fluid flow.

TYPE CC

Designed to allow quick easy alignment of pipe where the inside diameters are slightly out of round. The welder has the choice of "STRIKING OFF" the NUBS or leaving them intact to be melted into the weld mass of the first roof pass.

TYPE C

Designed for precise close tolerance fit-up. Type "C" NUBS automatically sets root gap. The NUBS melt with the metal to give complete penetration and fusion.

PLAIN TYPE

Rings have flat outer surface with beveled internal edges and flat inner land.

MACHINED RINGS

Robvon also manufactures machined rings to customer's specifications. All fabricated solid machined rings x-rayed.

Available in carbon steel, wrought iron, chrome alloys, stainless steel, aluminum and copper. Write for full information.

675 GARDEN STREET
ELIZABETH, NEW JERSEY
ELizabeth 2-9613

ROBVON
BACKING RING COMPANY

For more facts circle 322 on Reader Service card, p 107

INCREASE EFFICIENCY AND DECREASE COSTS WITH METROPOLITAN MAINTENANCE PRODUCTS

DUBOTH®
BOILER FEED WATER TREATMENTS
VAPORENE®
AIR CONDITIONING WATER TREATMENTS
SLUDGOUT®
FUEL OIL ADDITIVE FORMULATIONS
SOOTRACIDE®
SOOT AND SLAG ELIMINATOR
EZ TREAT®
COMPLETE TREATMENT FOR SMALL AIR CONDITIONING
DESCALER®
AIR CONDITIONING AND BOILER SCALE REMOVERS
CORRODINE®
STEAM & RETURN LINE TREATMENT
CORRODICIDE®
TREATMENT FOR GENERAL WATER SUPPLY SYSTEMS

As They Have For 40 Years, Engineers Everywhere Today Rely On METROPOLITAN'S Quality Chemical Maintenance Products And Consulting Services.

Through Scientific Field Surveys And Laboratory Analyses METROPOLITAN Works Closely With You To Find The Right Answers To Your Specific Problems.

To Prevent Or Eliminate Problems Of Scale, Corrosion, Slime, Soot, Slag, Sludge Caused By Impurities In Water And Fuels . . . In Boilers, Cooling Towers, Evaporative Condensers, Storage Tanks, Steam & Return Lines, General Water Supply Systems . . . In Industrial Plants, Office Buildings, Apartment Houses, Public Institutions, Hotels, Theaters, Stores . . .

ASK FOR THE MAN FROM METROPOLITAN. HE HAS THE CHEMICAL SOLUTION FOR YOU.

See our Representative in your area or write us for complete information.

METROPOLITAN REFINING CO., INC.
50-23 TWENTY-THIRD STREET
LONG ISLAND CITY 1, N.Y.

Bookshelf

How to Determine Economic Thickness of Insulation. *By W C Turner, Union Carbide Corporation, et al. $8.00. National Insulation Manufacturers Assn, 441 Lexington Ave, New York 17, N.Y.*

Extensive tables and charts solve the problem of economic insulation thickness. Capital-investment curves cover steam costs from $2 to $24 per lb per hr with 5- to 40-yr depreciation periods. In addition to flat surfaces, piping is covered in sizes from ½ to 36 in.

Economic thickness can be figured in four basic steps: determine (1) insulation-cost factor (2) cost-of-heat factor (3) insulation conductivity and (4) temperature differential. With these factors at hand, you can quickly arrive at the economic thickness for your particular application.

Proceedings of the International Clean Air Conference. *290 pp, $4.75 (including postage). National Society for Clean Air, Field House, Breams Bldgs, London EC 4, England.*

This book contains 78 papers from 17 countries. They were presented at the Conference in London in October 1959. Papers are grouped according to subject. Reviews of papers are included, together with general discussions that followed each presentation.

Number of papers, varied aspects of air-pollution problems covered and number of countries represented make this the widest and most international survey of the problem to be published to date.

Noise Reduction. *Edited by L L Beranek. 717 pp, 6 1/2 x 9 1/2, $14.50. McGraw-Hill Book Company, 330 W 42nd St, New York 36, N.Y.*

Some 19 engineers in noise reduction wrote this book. Its purpose: present the fundamentals of noise reduction for engineers who are not acoustics specialists. But because the material is graded in complexity, elementary in the early chapters and leading to most advanced concepts, acoustical specialists will also find the book of value. And it should be a help to airport, mechanical, power, aeronautical and electrical engineers who would like a general foundation.

SOLVE THESE NINE KEY WATER HANDLING PROBLEMS IN YOUR POWER PLANT WITH PEERLESS PUMPS

apply these proven-in-use pumps to cover a broad range of services in circulating, boosting, draining and transfer applications...

Producing power calls for equipment that can meet the rigors of continuous day-in, day-out performance. It calls for top performing pumps teamed with maximum engineering stamina.

It's a standard that Peerless meets and beats with ease. Small wonder then that Peerless equipment is selected in job after job. But Peerless offers you another added plus—careful, conscientious field engineering service. It's there when you want it, and it is there to help you in planning the best practical methods for handling the various pumping jobs you have. Here's another point to consider. The Peerless line is a complete one. Select your needs from pumps ranging from small fractional horsepower models to giant units capable of moving up to 220,000 gpm. Check the pumps listed below and request your copies of the bulletin you wish sent to you. Write Peerless Pump, Hydrodynamics Division, Food Machinery and Chemical Corporation at 301 West Avenue 26, Los Angeles 31, California, or 2005 Northwestern Avenue, Indianapolis 8, Indiana.

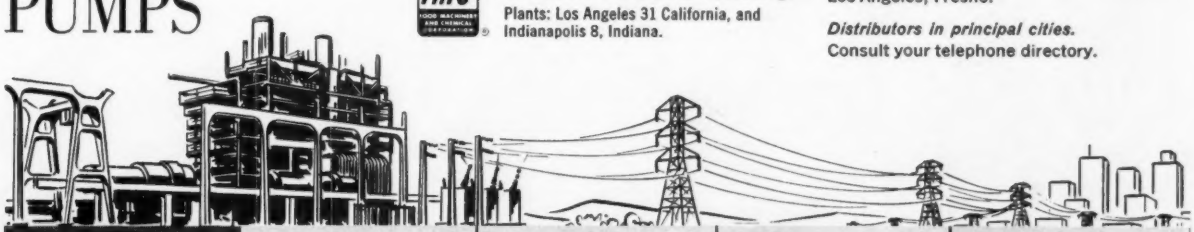
Putting Ideas to Work

PEERLESS PUMP
HYDRODYNAMICS DIVISION

Plants: Los Angeles 31 California, and Indianapolis 8, Indiana.

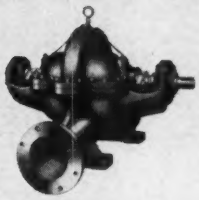
Offices: New York; Detroit; Chicago; Cleveland; Indianapolis; St. Louis; San Francisco; Atlanta; Plainview; Lubbock; Phoenix; Albuquerque; Los Angeles; Fresno.

Distributors in principal cities. Consult your telephone directory.



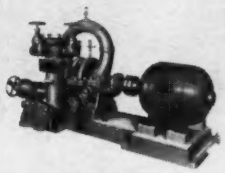
PEERLESS PUMP

GET THE JOB DONE



BOOSTER, CIRCULATING SERVICE

Horizontal Split Case Peerless TYPE A offers widest possible application in water pumping. Broad range of capacities and heads. Request Bulletin B-1300.



FIRE PREVENTION AND CONTROL

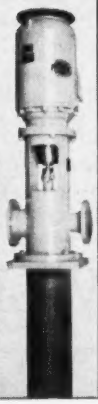
Select from vertical and horizontal FIRE PUMP models. All models are approved by Underwriters Lab and Associated Factory Mutual Fire Insurance Companies. Request Bulletin B-1500.

CONDENSER CIRCULATING SERVICE

Close Coupled HYDRO-FOIL pumps can be installed for wet or dry pit application. Extremely adaptable where space is limited. Request Bulletin B-148.

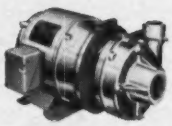
COOLING TOWER SERVICE

The Peerless lineup of VERTICAL INDUSTRIAL SERVICE pumps are extremely efficient, require little maintenance. Install them inside or outside. Request Bulletin B-505.



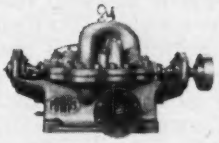
HEATER DRAIN, CONDENSATE RETURN SERVICE

Peerless HYDRO-LINE® pumps handle fluids up to 400°F. Will operate with any available NPSH. Request Bulletin B-1700.



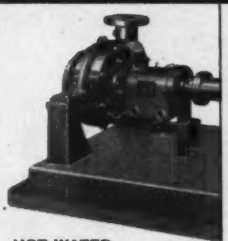
IN-PLANT CHILLED WATER PUMPS

End suction centrifugal FLUIDYNE® pumps are highly versatile in application, extremely efficient in service, and economical to operate. Models in all desired sizes. Request Bulletin B-2300.



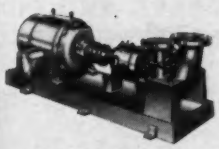
EVAPORATOR FEED, BOILER WASH, HEATER DRAIN

Peerless TU and TUT pumps have internal or loop cross-over. Multi-stage design allow pumps to develop high head and capacity from a compact unit. Request Bulletin B-1400.



HOT WATER, TRANSFER CHEMICAL FEED

Select from a comprehensive line of Peerless TYPE DM AND DMR pumps. Unsurpassed for handling superheated water and chemical fluids. Request Bulletins B-1608, B-1610.



BOILER LANCERS, HEATER DRAIN

A heavy duty, packing gland type pump, the Peerless TYPE PR is specially designed for heavy pumping assignments. Handles hot or cold liquids with equal efficiency. Request Bulletin B-1605.

For more facts circle 324 on Reader Service card, p 107

J-M packing for valves

J-M packing for pumps

...A SIMPLE RULE-OF-THUMB THAT LETS YOU REDUCE PACKINGS INVENTORY ...AND STILL HANDLE 9 OUT OF 10 VALVE AND PUMP PACKING JOBS!

FOR VALVES, J-M THERMO-CORE® (black) offers excellent heat resistance, maximum sealing under least compression, and adapts readily to equipment variations. For general use, Style No. 397 is recommended. This style consists of Inconel-reinforced asbestos yarns . . . braided over a soft center core of graphite and 100% white asbestos.

FOR PUMPS, J-M CHEMPAC® (white) combines the excellent sealing and heat-resistant qualities of asbestos with Teflon's immunity to almost all chemical and solvent action. Chempac Style No. 2009 is recommended to give you long, efficient and economical service on the majority of your pump, expansion joint and agitator applications.

For special conditions – or for any other mechanical packings application you can name–Johns-Manville produces the industry's most complete range of packing styles. These are described in J-M's new 64-page Mechanical Packings Book. It is designed to help you select the packing best suited to each particular requirement. For a free copy of PK-131A, write to Johns-Manville, Box 14, New York 16, N. Y. In Canada, address Port Credit, Ontario. Cable address: Johnmanvil.

JOHNS-MANVILLE

STEVE ELONKA
Associate Editor in Charge

Clearly written instructions key PM at Boeing

By STEVE ELONKA, Associate Editor

Sometimes the most vital part of your *PM*—preventive maintenance—program is simply a matter of knowing *what* to service or check *when*—and then making sure the checking and servicing gets done. But the only way you can be sure they get done is to keep accurate records, check lists, light-off sheets, based on both manufacturers' recommendations and your own knowledge of the incidence of failure. Everything is in writing.

When it comes to *PM*, industry in general can learn a lot from the airplane firms. The same alertness flight personnel practice in the air is followed through by aircraft people in their manufacturing plants. Turning out the big planes is a most exacting operation, with production schedules depending on reliable energy-systems supply. These services must not fail.

At the Boeing Airplane Co plant I visited in Seattle, Washington, power-plant supervisor Tom Keene and electrical-service manager Bob Carleson showed me the maintenance routines they use to prevent downtime. Complete instructions and records guide all *PM* work at Boeing.

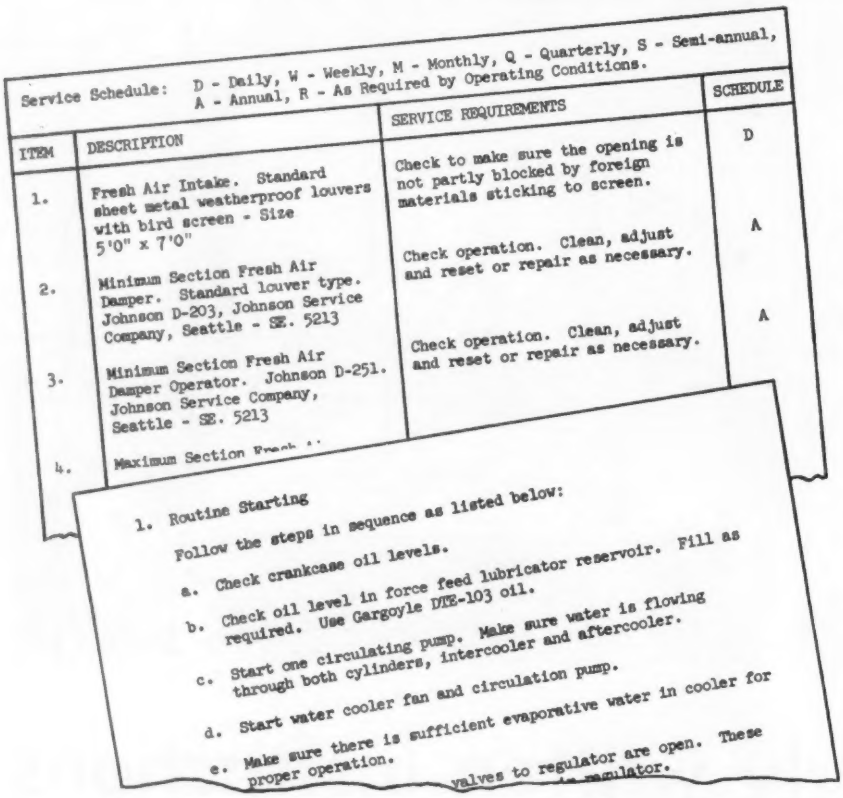
continued

Instruction books and *PM* check sheets aim to cover every contingency

On these two pages, we'll sample the various types of paperwork. Every component of every unit under the care of Tom and Bob is cataloged, described, itemized; for each unit, records include (1) comprehensive description of the equipment (2) mechanical drawings with numbered components (3) instruction sheets detailing each job in step-by-step sequence. For example, instructions show how to start up a unit that has been shut down for a long time, and also the procedure for daily startups.

These instructions leave nothing to chance. The only way a maintenance man can possibly pull a boner is if he fails to follow the instructions he takes to the job. But even that is pretty well covered, since he must indicate on his check list that each operation is complete.

Instruction books condense manufacturers' recommendations



Service Schedule: D - Daily, W - Weekly, M - Monthly, Q - Quarterly, S - Semi-annual, A - Annual, R - As Required by Operating Conditions.

ITEM	DESCRIPTION	SERVICE REQUIREMENTS	SCHEDULE
1.	Fresh Air Intake. Standard sheet metal weatherproof louvers with bird screen - Size 5'0" x 7'0"	Check to make sure the opening is not partly blocked by foreign materials sticking to screen.	D
2.	Minimum Section Fresh Air Damper. Standard louver type. Johnson D-203, Johnson Service Company, Seattle - SE. 5213	Check operation. Clean, adjust and reset or repair as necessary.	A
3.	Minimum Section Fresh Air Damper Operator. Johnson D-251. Johnson Service Company, Seattle - SE. 5213	Check operation. Clean, adjust and reset or repair as necessary.	A
4.	Maximum Section Fresh ...		

1. Routine Starting

Follow the steps in sequence as listed below:

a. Check crankcase oil levels.

b. Check oil level in force feed lubricator reservoir. Fill as required. Use Gargoyle DTE-103 oil.

c. Start one circulating pump. Make sure water is flowing through both cylinders, intercooler and aftercooler.

d. Start water cooler fan and circulation pump.

e. Make sure there is sufficient evaporative water in cooler for proper operation.

... valves to regulator are open. These ... regulator.

Heating system

Maintenance and service procedure for heating and ventilating system is a 17-p set of instructions, ending with a list of 18 manufacturers' service manuals that pertain to various pieces of equipment in the system. And for each energy system at Boeing, a similar master set of instructions is drawn up and kept handy.

Air compressors

Routine starting of large air compressor is covered in a brochure including the responsibilities of those who operate and service compressors, a description of equipment, detailed operating information, inspection and servicing requirements. This info mastered, the instructions and inspection charts follow: daily log sheets; monthly, semi-annual and annual inspection sheets.

Inspection sheets check off step-by-step procedure

Item No.	Item Description	Service Requirements	Condition						
			Mon	Tues	Wed	Thurs	Fri	Sat	Sun
22a	Air Filter	Inspect to see that indicating system shows normal operation. Both red and clear lamps should be on for normal operation and off when a short circuit exists. Advise electrician if malfunction exists.							
26a	Filter and Pressure Reducer for Supply Air to Johnson Controllers	Check filter assembly. Blow down filter. Air pressure should be 15 psig leaving reducer							
28	Expansion Tank 24" x 72" Tank	Check water level in tank. If water is low, check feed water system for faulty operation and/or hot water line for leaks. Feed water is admitted automatically through a pressure reducing valve set at 20 psig. Advise plumber of malfunction.							

Daily . . .

inspection of heating, ventilating and air-conditioning system gives marching orders for cleaning, lubricating and adjusting. The maintenance man is told, "state what was adjusted; new unit or part required; explain what failed, why it failed and what was done." There's a space which he uses to warn the next maintenance man about anything unusual that might need attention.

Monthly . . .

inspection sheet lists eight items to be checked in the a-c system proper and eight more items in its cooling tower. Like every other sheet, this must be signed by the mechanic making the inspection and by his foreman, who must approve each item.

Plumber's check list covers such items as the oil-filter pump, steam traps, strainers for circulating and condensate pumps, circulating pump and motor and condensate pump in system.

Item No.	Item Description	Service Requirements	Condition
23a	Air Conditioning Unit for Telecomputing Room	1. Check water temperature leaving condenser. Should not exceed 95° F. 2. Wipe off dust and dirt in unit. 3. Check for loose tubing connections. 4. Check evaporator coils and lines for icing. 5. Check c	

Item No.	Item Description	Service Requirements	Condition
12a	Steam Traps	Check operation of trap and blowdown strainer. South Mechanical Room Central Mechanical Room North Mechanical Room Hangar Unit Heaters Control Tower Air Conditioning Unit	
34a	Strainers for	Blow down until water runs clear.	

Semiannual . . .

inspection sheets are again drawn up for the air-conditioning-system plumber. These sheets list various items to be checked twice a year on the steam-control valves and mixing valves in the system.

Item No.	Item Description	Service Requirements	Condition
11b	Steam Control Valves	Inspect valves. Tighten packing only enough to prevent leaks. Replace any leaky diaphragms. If valve does not close tightly, replace the valve disks. South Mechanical Room (4 valves) Central Mechanical Room (2 valves) North Mechanical Room (4 valves) Hangar Unit Heaters	

Annual . . .

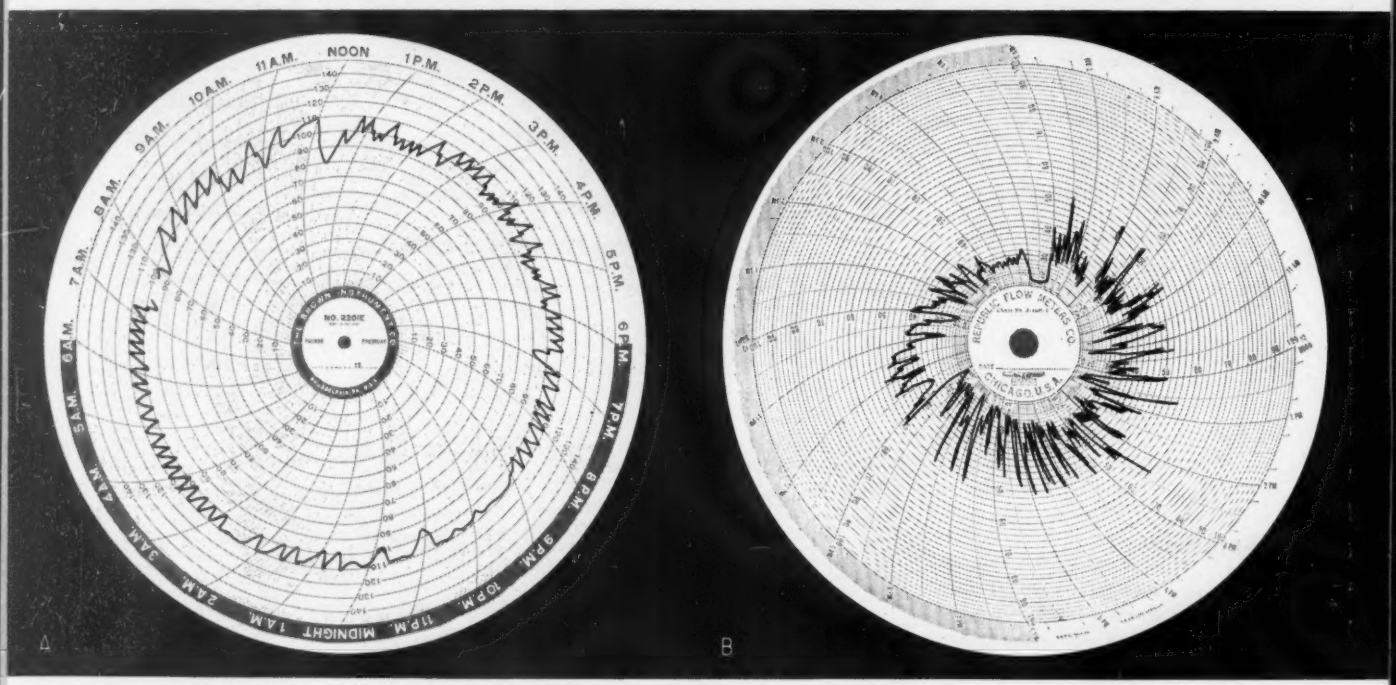
inspection sheet for a-c system lists 27 separate points that need once-a-year checking to give optimum performance. Here again, every possible problem is spelled out. For example: "set sensitivity as high as possible (5 psig per F) without hunting. Reset thermostat at 40 F" leaves no question about what is to be done. The 6-p form lists about 100 specific check points.

Vault-inspection list (prior to date of de-energizing) details 13 points to be checked. Accent is on safety—and when a problem comes up, other department heads must be kept informed.

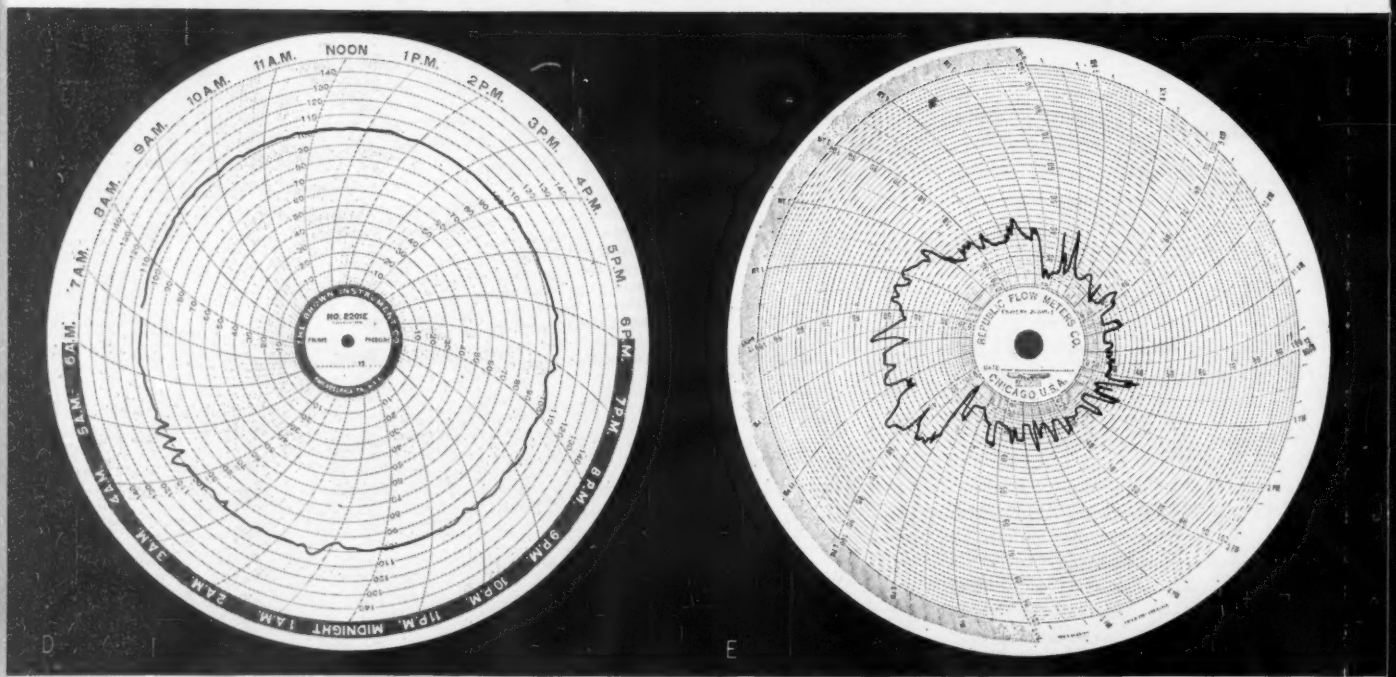
Item No.	Item Description	Service Requirements	Condition
9	Supply Intake Air Mixture Temperature Thermostat (Direct Acting)	Check operation. Move setting manually. Control pressure should equal supply pressure when thermostat setting is moved 1½° F. below actual mixture temperature. Control pressure should be 0 psig when moved 1½° F. above. Adjust or repair as necessary. Set sensitivity as high as possible (5 psig/° F.) without hunting. Reset thermostat at 40° F.	
		...l Room	
11b		1. Test transformer fluids. (See page 8). 2. Procure and test new fluid as required. 3. Write letter to departments which will be affected by vault shutdown. 4. Arrange for required accessories: a. Compressed air b. Vacuum cleaners c. Emergency power d. Cleaning fluids and cloths 5. Calibrate and adjust relays and needed. 6.	Condition ✓ - Satisfactory X - Unsatisfactory Insp.by / As found / As left

We stopped

Before: two controls on boiler water columns made pressure swing



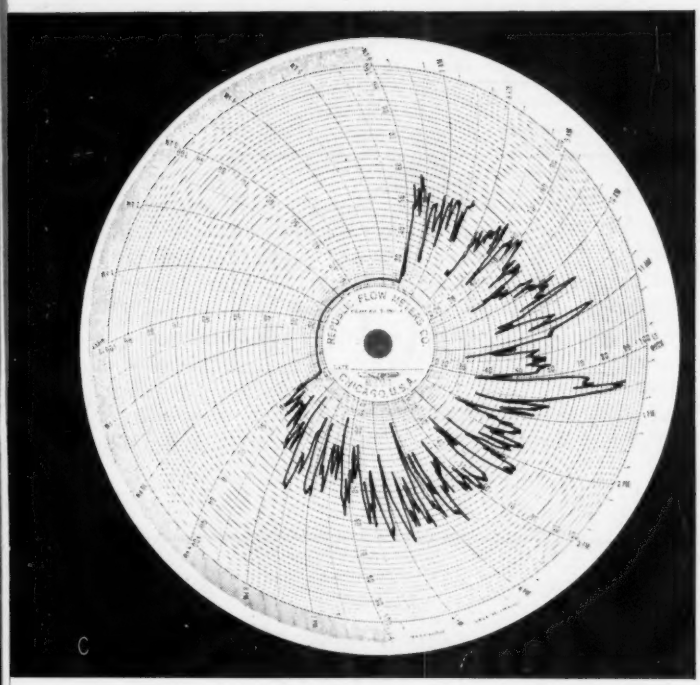
After: single control on the steam header keeps pressure constant

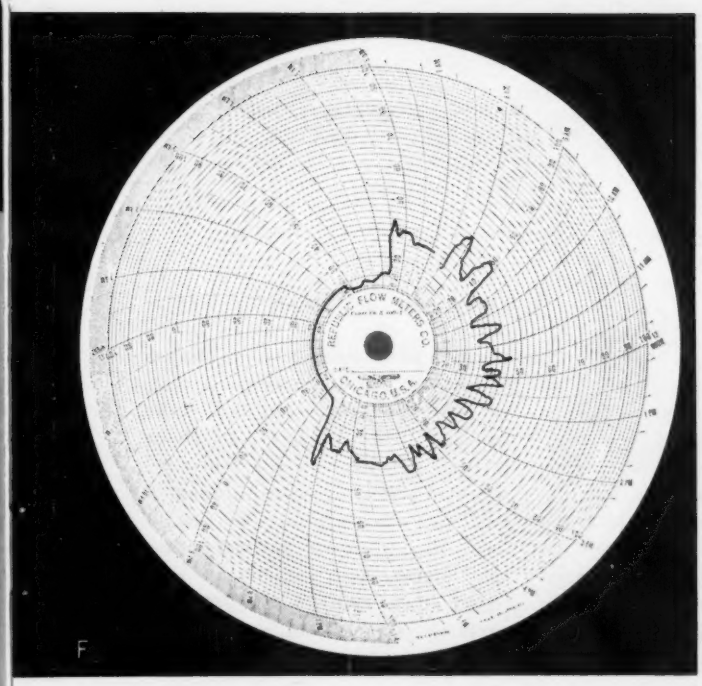


Note: Chart E was improperly installed, shows loads reversed

steam-pressure fluctuations

By MILTON N KRAUS, Hillsdale, N. J.





Two of our pulverized-coal-fired hrt boilers were converted to oil by installing a fully automatic rotary-cup oil burner in each furnace. According to specs, both burners would be modulating, capable of maintaining a constant pressure on the steam header.

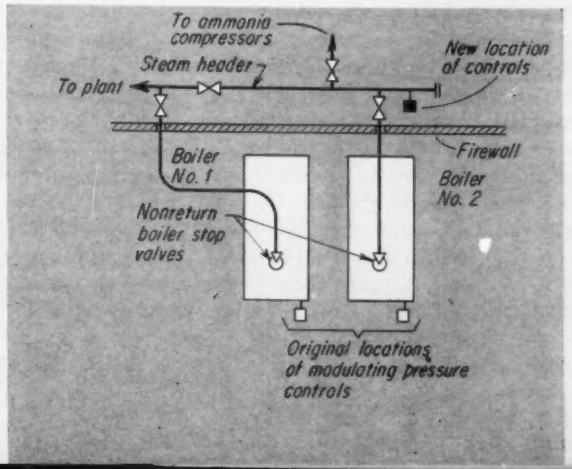
But on startup, with boilers paralleled, steam pressure fluctuated wildly (chart *A*). When we checked the burners, we found they were acting independently, each according to the setting of the modulating pressure controller for the boiler it was firing. This swung the load from one boiler to the other, and so the steam-header pressure fluctuated. Another complication: the steam flowmeter charts showed that load wasn't distributing equally between the boilers (charts *B* and *C*).

Doing a little detective work, I observed that constant pressure could be maintained for a short time. But this happened only when one boiler was in operation at high rating and the other boiler cut out of service. Then, as the load dropped below the turndown ratio for this type of burner control, the operating burner started to go on and off rather than modulate.

I tried to set the controllers to permit parallel operation of the burners, but my attempts didn't pan out. Then I realized that the controllers were mounted on the boiler water-column connections, sketch below. In this location they were subjected to steam-drum pressures which varied with the load because of the difference in pressure drop caused by different lengths of boiler leads and differences in action of the nonreturn stop valves. So equal setting of the controllers became almost impossible.

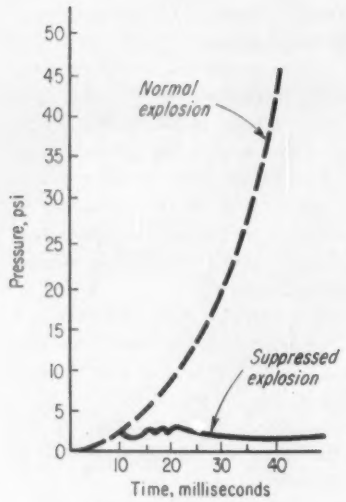
My final solution: remove the individual modulating pressure controllers, and instead of them, connect a single controller directly to the header where it reads the same pressure for both boilers. Single controller was equipped with dual potentiometers, one for each burner control. As a result, we now have a constant steam-header pressure (chart *D*) and load is distributed better between the two boilers (charts *E* and *F*). The pressure fluctuations on chart *D* occurred with only one boiler on the line, at loads below turndown ratio.

DIFFERENT LENGTHS of steam leads relayed different pressures to the controllers. One control on header avoids problem

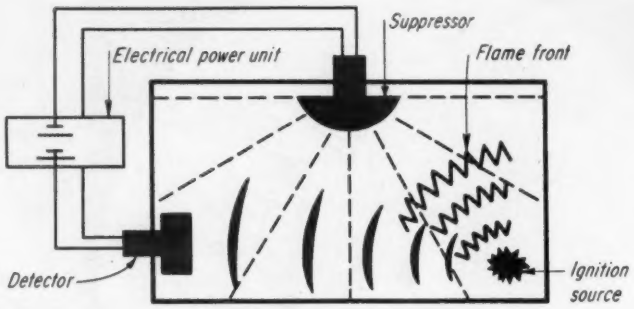


Nip dangerous explosions

No blast is truly instantaneous

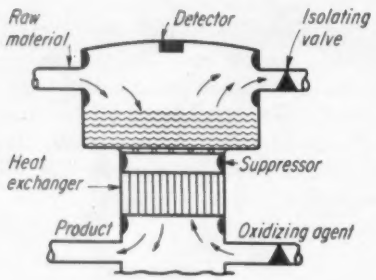


TIME LAG before the forces build up is basis for this explosion-protection system



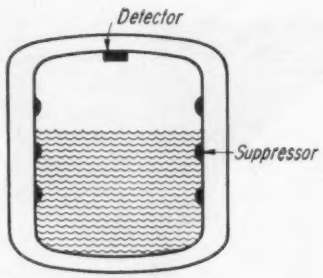
SUPPRESSION SYSTEM jumps to action, sensing an incipient blast, then stopping it

Protection centers around this equipment



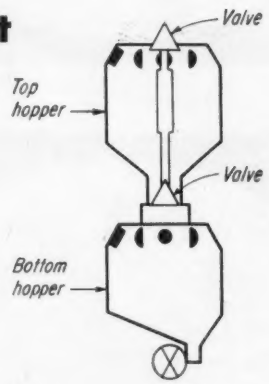
Chemical reactor . . .

is protected by advance isolation and suppression. In the reactor, severe explosion hazard comes if an oxidizing agent combines with the raw material. System must not only suppress the explosion in the main chamber, but prevent its spread into nearby areas of the plant—to do this, the two high-speed isolation valves close rapidly. An alternate protective system then controls overpressure that is caused by runaway reactions.



Flammable-liquid . . .

explosions are suppressed only. Illustration represents tank used for storing highly flammable liquids. Protection system does not completely stop the explosion, but keeps the wall of the tank from bursting when explosive pressures build up. So personnel are safe and production continues on schedule. Several hemispherical suppressors, mounted on the inner walls of the storage tank, protect liquid fill at any level.



Pulverized-fuel plant . . .

is protected by suppression. Danger of ignition, due to tramp iron, flint, etc, exists at the inlet and outlet valves. So bottom hopper is far above atmospheric pressure and feeds into a system under pressure. Top hopper receives pulverized fuel by gravity feed. Then it closes, feeds into bottom hopper. Both hoppers are protected by a ring of hemispherical suppressors, as shown, containing a liquid suppressant suitable for coal.

in the bud

OPERATORS' NOTEBOOK 151

By STEVE ELONKA, Associate Editor

Because a blast seems instantaneous to the naked eye, most of us think that an explosion cannot be stopped. But this is not so. There is a finite lapse of time—usually some 40 milliseconds—between ignition of an explosion in a closed space and the buildup of destructive pressures, as curve at left shows. With proper equipment, you can use this time to stop a blast in its tracks, before it gets out of hand.

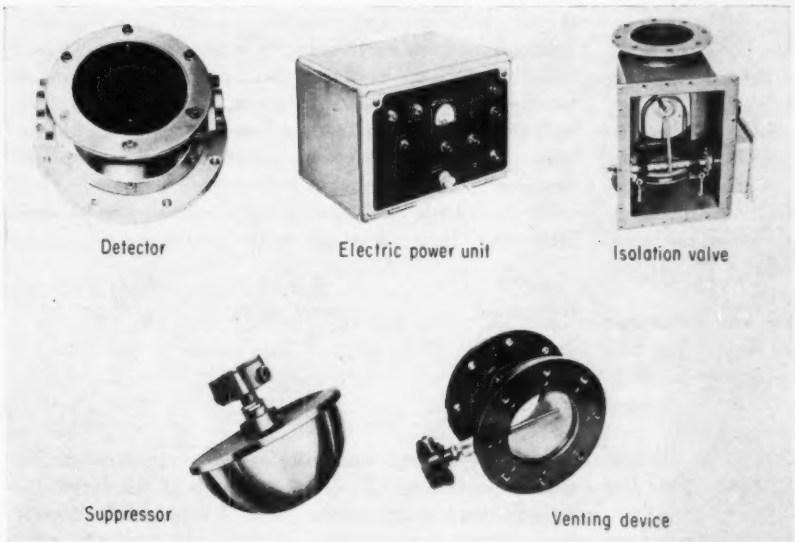
System explained on these pages is based on this vital time lag. In a few milliseconds, system detects the very beginning of the explosion, by sensing either initial pressure buildup or the first tiny flash of flame, and reacts to snuff it out. The blast is made harmless by a combination of actions: (1) Suppression envelops the explosion. (2) Venting opens a path to the atmosphere for controlled pressure relief. (3) Advance inerting introduces suppressant into remote areas to prevent secondary explosions or fires. (4) Isolation blocks the explosion, keeps it out of other areas. (5) Plant or equipment involved automatically shuts down, thus preventing further damage.

Since 1956, Fenwal Inc of Ashland, Mass. has been trying this system at a secluded test site. Their main research objective: investigate the explosion characteristics of various materials.

Nearly every process industry—chemical, petroleum refining, plastics, milling—must face some degree of explosion hazard. Certain metallic dusts create explosion potential in the metalworking industry. Flour and wood dusts can be dangerous. And the potential is lurking in thermal as well as atomic power plants.

Of course, adequate preventive maintenance will always be a prime factor in keeping explosions from happening. But it's a good idea not to depend more than you can help upon fallible human reactions. As we reported in POWER, June 1959, p 237, a survey in the power-generation field showed that human failure contributed to 90% of the explosions occurring in one recent year. This automatic system aims to limit damage to the closed space where explosion began, and to reduce the human factor. Let's see how it works to protect your equipment.

Here are the basic protective elements



EVERY PROTECTIVE SYSTEM contains above elements in some combination: *Detector* operates from rate of pressure rise or static pressure setting, or senses radiation. *Power unit* with standby batteries assures positive action. High-speed *isolation valve* keeps the explosion from spreading. *Suppressor* discharges liquid suppressant to extinguish explosion, rendering it harmless. *Venting device* opens when an explosion is detected to relieve explosion pressure

Each system is tailored to its specific job—but made up of standard parts. Heart of any system is its *explosion detector*. Either a pressure or a radiation device, it senses an incipient explosion, generates an electrical signal. Radiation detector can distinguish explosive flame; natural and artificial light won't set it off.

Power unit sends energy to operate devices in system. Batteries take over if plant power fails. *Suppressor* is either an easily ruptured container or a setup of high-rate-discharge bottles. Both contain liquid suppressants.

Venting device has a diaphragm which shatters to relieve pressure. *Isolation valve* is held open against spring pressure by a metal link. Inside the link is an explosive detonator which breaks the link in time of trouble. Then valve closes firmly, stopping process flow.

Demineralizer operating costs revolve around two items—the price of chemicals and throughput quality and quantity. Review the factors that influence these items; you'll find you can boost plant efficiency by . . .

Optimum ion-exchange

By C T DICKERT and R HETHERINGTON, Rohm and Haas Company

Regeneration of ion-exchange resins offers an excellent opportunity to cut operating costs and up plant efficiency. To see how close your plant comes to optimum, you must carefully review all influencing factors and compare your actual and design chemical costs.

Cation-exchange resins work alone for softening or dealkalizing or in combination with anion-exchange resins for deionizing water supplies. They can be used in either a sodium or hydrogen cycle regenerated with NaCl or H_2SO_4 (or less commonly with HCl).

Suppose we define regeneration efficiency as lb of regenerant per kgr of ions exchanged. For strong-acid and strong-base exchangers, efficiency usually decreases as regeneration level (lb regenerant per cu ft of resin) increases. Chart 1 shows this for a cation-exchange resin regenerated with NaCl. Conclusion: most efficient regeneration calls for lowest possible regeneration level consistent with quality of water you need. But this means more frequent regeneration—higher labor costs and more downtime. So you will have to balance these factors out for your particular plant.

Chart 2 shows the relationship between acid-regeneration level and efficiency. Here, too, efficiency depends on flow rates and concentration. Efficiency generally gains with increased concentration and falls with increased flow rate. So you again have to arrive at an optimum concentration and a reasonable flow rate so that regeneration will not incur excessive downtime.

Softeners are designed to be regenerated at about one gpm per cu ft with a salt concentration of 10%; if this flow rate can be decreased, efficiency improvement is possible with a higher brine concentration. Optimum concentration for hydrogen-cycle cation exchangers is more critical and depends largely on the character of the raw water. This is particularly true with H_2SO_4, where the controlling factor may well be the solubility of $CaSO_4$.

These general rules may guide your selection of acid concentrations in carbon-exchange regeneration at flow rates of 0.5 to 0.75 gpm per cu ft:

(1) If Ca-ion concentration in raw water is less than 20% of total cations, use 2% acid regardless of regenerant temperature

(2) If Ca-ion concentration is greater than 20% of total cations, Mg-to-total-hardness ratio less than 1:4 and regenerant temperature less than 60 F, use 2% acid

(3) If Ca concentration is greater than 20% of total cations, Mg-to-total-hardness ratio less than 1:4 and regenerant temperature greater than 60 F, a stepwise regeneration is necessary

(4) If Na amounts to more than 25% of total cations and Mg-to-total-hardness is 1:2 or greater, use 4% acid

(5) If Na amounts to more than 25% of total cations and Mg-to-hardness ratio is 3:4 or greater, use 5% acid

Stepwise regeneration, though inconvenient, is a must in some cases to prevent $CaSO_4$ precipitation. In the stepwise method, you start feeding acid at a low concentration with a high total flow rate. You then increase concentration by steps and simultaneously decrease the total flow rate. Acid economy dictates the flow-rate reduction with increased concentration: if flow rate were held constant, much of the highly concentrated acid would leak through and be wasted before reacting. But watch out for possible flow-distribution troubles. Flow rate must not drop to the point where even distribution of flow within the vessel is uncertain—drain and header construction control this minimum flow setting.

If you decide on stepwise regeneration, use at least three steps. Here's a typical 4-step program:

Fraction of regenerant	% of acid concentration	Flow rate, gpm per cu ft
¼	0.5	2.0
¼	1.0	1.5
¼	2.0	1.0
¼	5.0	0.5

Anion-exchange resins come in two varieties—strong and weak. Strongly basic resins are used whenever dissolved-silica concentration must be reduced. Weakly basic resins apply where weak acids such as H_2CO_3 need not be removed.

Strong-base resins, used in some demineralizers, are regenerated with a strong alkali; NaOH is usual here. Regenerant quantity should be held to the minimum consistent with desired effluent-water quality. Higher levels

regeneration

increase exchange capacity, *but* at the expense of regeneration efficiency. In any event, mercury-cell or rayon-grade NaOH should always be used.

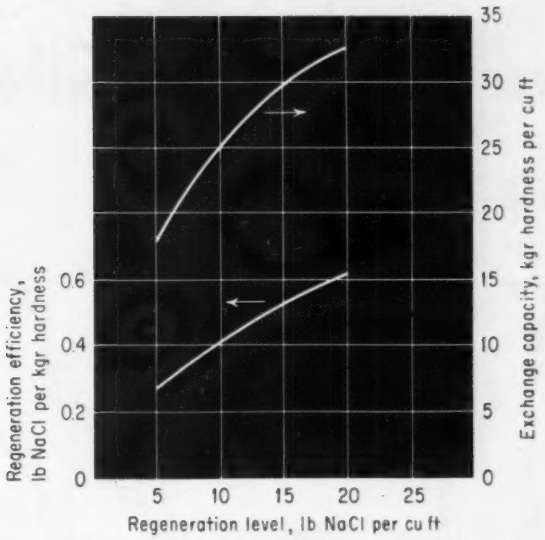
Regenerant concentration should be about 4%; flow rate should approximate 0.5 gpm per cu ft. If silica leakage and exchange capacity are important, heat regenerant to 120 F for Type I resins, 105 F for Type II. Chart 3 shows regenerant-temperature effect on silica capacity and leakage.

For backwashing and rinsing of anion-exchange resins use decationized water only. It will usually be available from a storage tank or, in a multibed system, from the cation unit direct.

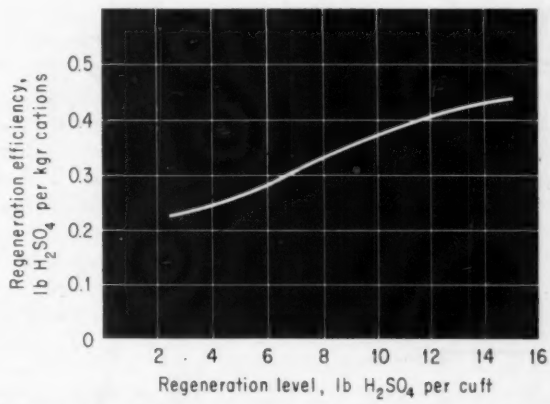
Weak-base anion resins are regenerated with NaOH, Na_2CO_3 or NH_4OH. The first two have been common for some time; the last is now getting a lot of attention as a result of resin-fouling problems.

Weakly basic anion resins commercially available have, in a few scattered instances, developed high rinse needs when regenerated with Na_2CO_3 or NaOH. In some cases rinse needs as high as 900 gal per cu ft have been reported. Research indicates that this may be due to the development of weakly *acidic* exchange sites on the resin beads. We don't, as yet, clearly understand the reactions, but it appears that when the resin is regenerated with strong alkali, sodium is exchanged onto these sites and bound ionically. Then, during rinsing, the sodium ions are slowly released by hydrolysis or by exchange with hydrogen ions in the rinse water. Result: a prolonged rinse and high anion-resin-effluent pH.

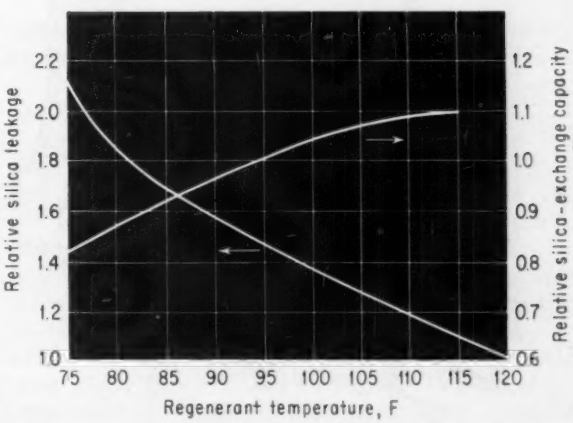
On the other hand, ammonia resins are held so loosely by these acidic groups that they hydrolyze off readily, avoiding high rinse needs. In addition, NH_4OH regeneration offers other advantages: some resins, regenerated with 3.0-lb NH_4OH per cu ft, will yield a slightly higher capacity and a higher water quality than when they're regenerated with 3.5-lb NaOH per cu ft. Attractive cost savings are thus possible in a 2-stage deionization system. Example: 50% caustic soda costs about $3 per cwt as NaOH, ammonia about $3.50 per cwt as NH_3. So you can cut operating costs by about $5.40 per regeneration if your system contains 100 ft of resin.



1 Increased salt means higher exchange capacity for sodium-cycle cation resins, but sacrifices regeneration efficiency



2 Increased acid during regeneration of a hydrogen-cycle exchanger reduces regeneration efficiency, lb H_2SO_4 per kgr cations



3 Temperature effect on anion-exchange operation: as temperature rises, exchange capacity increases and leakage goes down

"All the News That's Fit to Print"

The New York Times.

CITY EDITION

VOL. CX ..... No. 37,766 NEW YORK, WEDNESDAY, JUNE 14, 1961 FIVE CENTS

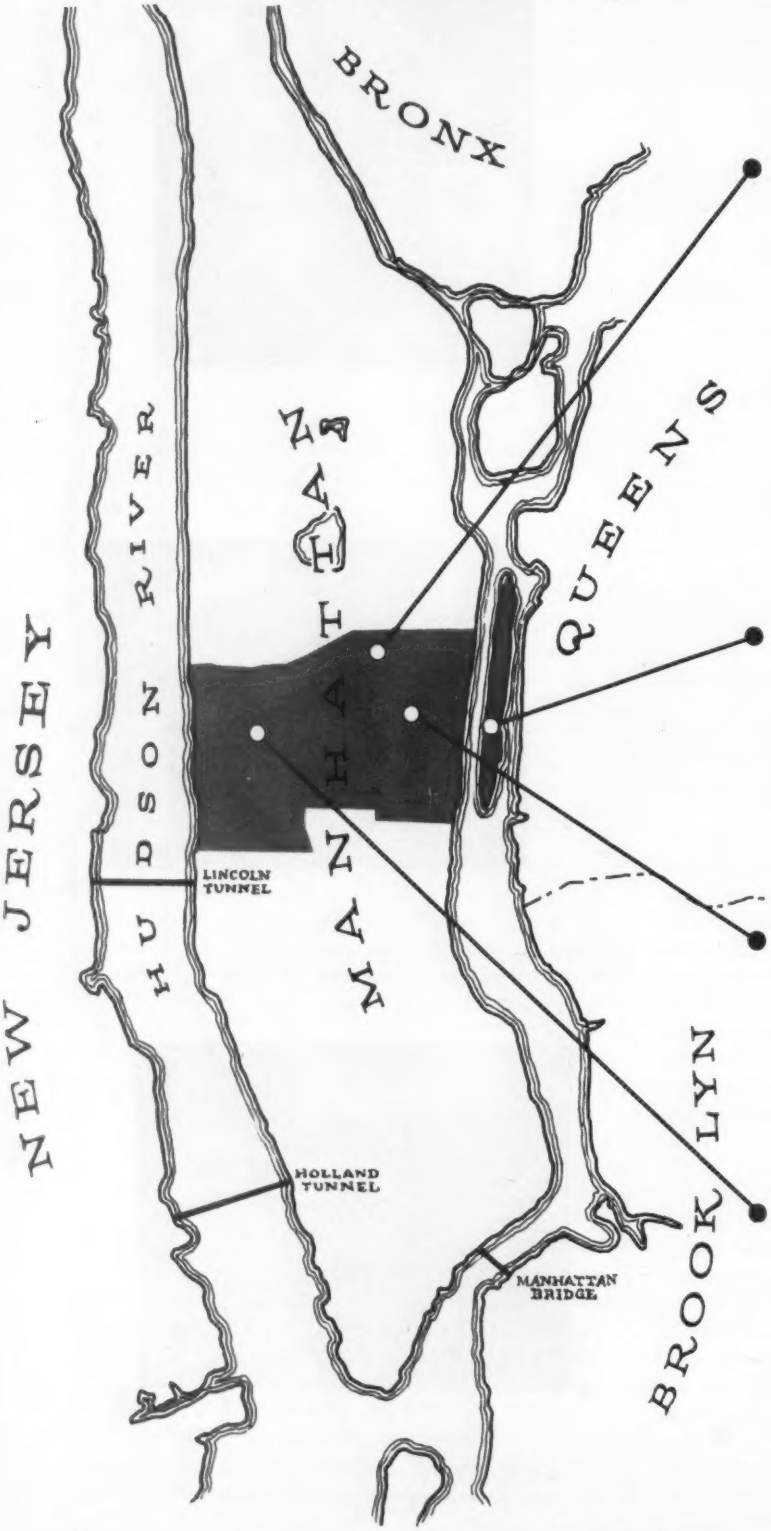
POWER BLACKOUT PARALYZES MID-MANHATTAN; STOPS IND SUBWAY IN THE EVENING RUSH HOUR; ELEVATORS ARE HALTED DURING RECORD HEAT

To Our Readers ... U.S. Arrests

Wide Area Dark

Traffic Lights Out

New York City midtown blackout



Four out of nine major hospitals had alternate power available

Lenox Hill Hospital

A new 100-kw ac diesel generator picked up emergency load in six sec to cover operating rooms, patients' vacuum system and some house services. Within 12 min, an older 500-kw dc diesel generator took on remaining ac load through an m-g set. Dc load was carried directly. There's an old 400-kw dc steam-engine generator to back up this emergency supply, but most air-conditioning steam load must be dumped to start it up.

Goldwater Memorial Hospital

A 75-kw diesel generator automatically started up and provided continuous power to respiratory patients' iron lungs, lighted their immediate area and provided other essential services for them.

New York Hospital

About 75% of their normal electrical load is met by house generators—this, of course, was not affected. Judicious switching quickly transferred essential services carried by outside power to house-generated power.

Roosevelt Hospital

Dc service from Con Edison stayed firm, operated some elevators, essential lighting. New 300-kw diesel generator goes on-line late this summer as emergency feed for refrigeration, operating rooms, essential corridor lighting and one elevator.

spotlights need for emergency power

In spite of Con Edison's high-continuity record, many feel emergency standby is still needed, especially in hospitals and other public buildings to protect health and safety. Here's a report on how midtown Manhattan hospitals met the June 13th blackout

By T W EDWARDS, Associate Editor

Last June 13th, at 1:55 in the afternoon, New York City temperature hit 96 F—breaking a 69-yr record for that date. At the same time Consolidated Edison's 1-hr peak reached a new high of 4431 mw.

About 3:30 pm, a substation breaker failed, but there was no immediate service interruption. However, when a second breaker failed at 5:00 pm, clearing operations tripped out other system breakers. Result: a 4-hr power outage in midtown New York, shaded area on map at left. There is no indication, however, that these failures were related to the high load and temperature.

But the incident did serve to highlight emergency-power facilities (or lack of them) in the affected area. Potentially most dangerous situations, of course, existed in nine major hospitals dotting the area. How did they rise to the emergency? Actually their attempts ran the gamut from almost complete power availability to flashlights and candles. Police and Civil Defense emergency equipment—portable generators and floodlights—were rushed to hospitals that were otherwise without power.

Probably the best-equipped hospital was Lenox Hill. Here they've kept, for standby service, a 500-kw dc diesel generator no longer on continuous duty. When needed, it powers some dc services and equipment directly and provides ac emergency power through an m-g set. But this machine, installed in 1945, takes about 12 min to get on the line—delay that can't be tolerated in a hospital. So they have a brand-new 100-kw ac diesel generator which took over some high-continuity services within six sec after the failure.

But this isn't all the equipment Lenox Hill has. To back up their emergency-diesel-power setup, an old dc steam-engine generator is also available. If diesel generator fails during a power emergency, air-conditioning-steam load can be dumped and the steam-engine generator started up. Future plans call for another boiler. Scheduled for normal duty, it will also make more steam available to run the engine should need arise.

Other hospitals met the emergency in a variety of ways, left, but several were caught with their kilowatts down. For some, the time of day helped—heavy operating-room load usually comes early in the day (of course, babies haven't heard of the rule yet!).

This power failure on top of the one two years ago has added fuel to the hospital emergency-power fires. The City of New York has plans—now in the hands of consulting engineers—for 13 diesel-generator sets in their own hospitals; sizes range from 225 to 1125 kw. These are designed to meet emergency loads only: operating rooms, elevators, corridors and refrigeration systems. All installations will provide automatic startup.

Many volunteer hospitals also have plans in various stages. Range of planned capability goes from bare emergency needs to full load. Roosevelt Hospital, of all the hospitals in the blackout area, is probably closest to completion of its emergency-power setup.

Civil Defense will help financially in some cases. Existing regulations provide for up to 50-50 split of costs for hospital emergency-power equipment. Recommended capability is 80% of full load, but this can vary widely depending on particular needs. There is also a provision for Civil Defense funds to help pay engineering-study costs leading to an approved emergency supply.

A new public building in the affected area, the New York Coliseum, has an emergency diesel generator to light exhibition-hall areas. It serves an emergency circuit and starts up automatically on outside power failure. Although no show happened to be in progress on July 13th, the emergency generator started up without a hitch.

Emergency power sometimes seems like the proverbial leaking roof. When it's not raining there's no point in fixing it; when the rains come, it's too late. But these recent power failures in New York City can't help but impress responsible engineers with the need that exists for adequate emergency-power supplies, especially where public health and safety are involved.

These **plant problems** could well be yours...

How can we measure vibration?

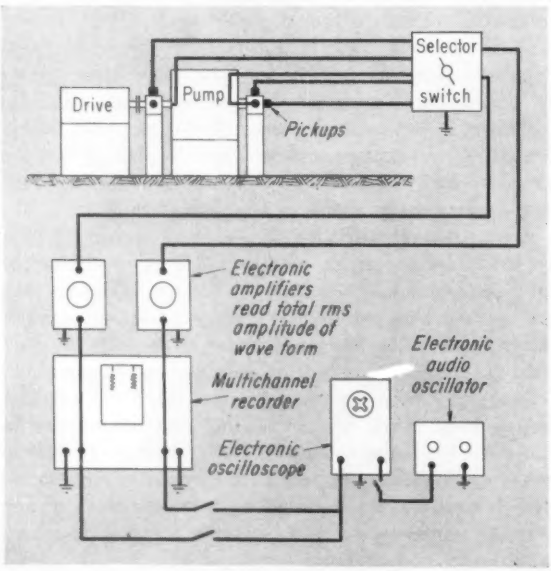
Our latest steam-generating cycle includes a motor-driven geared feedwater pump. Motor speed is 1800 rpm, pump speed is 6850 rpm. Pump discharges 406-F water at 2900 psig. The unit appeared to operate satisfactorily for well over a year.

During the year's operation we took periodic measurements of vibration on the bearing housings with an optical vibrometer. Readings always remained quite close to one mil, so we assumed no important vibration existed.

During our latest station outage we opened up the pump and were surprised to find internal cracking. Small incipient cracks appeared in impeller-vane fillets. We have seen enough of this kind of thing to know cracks were caused by high-frequency vibration.

Our problem: how do we get meaningful measurements of pump vibration? Obviously our old method missed. Can readers help us?—*HCK, May* POWER

Solutions . . .



Vibration analysis calls for complete instrumentation setup on the pump

The vibration problem described by *HCK* may be analyzed by instrumenting the pump to study vibration amplitudes and frequency of the complex wave form generated by the unit. The method is described in *Waveform Analysis* by R G Manley.

Instrumentation consists of several crystal or velocity type pickups positioned in the three principal planes and mounted on the bearing housing at both ends of the impeller. Spot checks can be made on the housing and on the rotating shaft with any one of several models of hand-held mechanical vibrographs. Just make sure that the measured values are for the shaft and not the vibration of the probe finger itself. The first step is making a check of the drive unit to be sure that the pump is actually the source of troublesome vibration.

Diagrammatically, this instrumentation can be of the monitoring type on a semipermanent basis. One arrangement, at left, using the pickups just described, has each

...Here's how Power readers would tackle them

BOB MARKS, Associate Editor

lead going into a control box. A selector switch on this box picks desired location and the plane to be recorded. Signal is fed into a medium-frequency amplifier which reads total rms amplitude of the complex wave form on a calibrated meter. It then goes to a multichannel vibration recorder. After the desired gain settings have been established and calibration runs made on the shake-table of the complete system, frequency and amplitude of the predominant peaks of the wave form may be determined. This is done by assigning them values in accordance with the calibration curves and the known total amplitude taken from the meter. Frequency can be counted from the chart speed of the vibration recorder.

Determining frequency of some of the minor amplitudes may be difficult. According to *HCK*, the optical vibrometer did not indicate existence of a vibration problem. All vibration instruments change sensitivity with variations in frequency. High frequency values can be determined with an oscilloscope and an audio-frequency oscillator. Using the pickup and amplifier arrangement already prepared, the vibration signal is fed into the vertical plates of an oscilloscope. Oscillator is then tuned through the range of possible frequencies that may be expected from this type of problem.

A crown-wheel effect may be found, variation of a Lissajous configuration. Frequency is calculated by counting the points on the crown and multiplying this by the frequency of the injected signal. This technique is fully described in standard texts on the use of oscilloscopes.

A complete discussion of this vibration study may seem a bit complicated. But in practice it is really quite simple. Most complicated and time-consuming part is calibrating the complete hookup and obtaining the equipment needed.

The following list is a guide to the type of equipment that can be employed in this kind of test hookup: (1) Consolidated 4-102 velocity type pickups (2) Endevco-226 or 2228 crystal type pickups with cath follower (3) Eastman 910 adhesive (5) Audio amplifiers with rms meter — Consolidated, General Radio, Endevco, etc (6) Brush Mk 2 multichannel ink recorder (7) electronic oscilloscope (8) audio-signal generator—Packard Hewlett (9) coaxial cords, sockets and plugs for hookup and (10) hand-held mechanical vibration recorder.

W M RAINES, *Torrance, Calif.*

Level of vibration is much too high

HCK states that no important vibration existed because the vibration level stayed close to one mil. Actually, one mil at 6850 rpm is far from being a smooth condition. The vibration tolerance chart in POWER's June '59 special report, *Balancing Rotating Machinery*, shows one mil at 6850 rpm as a rough condition. *HCK*'s vibration level is of this magnitude and requires immediate correction.

In problems of this sort, frequency of vibration is as important as amplitude. If the predominant frequency of vibration is 6850 cpm this indicates a condition of imbalance or possibly misalignment. Higher frequencies in such a pump could result from gears or blade frequency of the impeller.

Obviously, *HCK* could make good use of an instrument which indicates frequency as well as amplitude. For this purpose an instrument such as the model shown on page 219 of the June issue can be employed. This device not only indicates frequency but also shows the wave form—extremely helpful in vibration analysis.

R E BATHERMAN, *New York, N.Y.*

Pump metallurgy plays important role

From *HCK*'s description of the problem we cannot be sure that his pump is in distress as the result of vibration. It is unlikely that vibration frequencies of the same order as the operating speed have caused cracking in the impeller-vane fillets. Feed-pump impellers are generally of the totally enclosed type and the vanes are supported by both front and back shrouds. Open impellers have the vanes supported only at the back shroud and under severe conditions, relative motion between vanes and the shroud may cause fatigue failure. Note, however, that the high ductility of most feed-pump impeller materials prevents vane failures by redistributing stresses that accompany yielding of the material.

Unless a high frequency, such as generated by impeller vanes passing diffuser vanes, is present, vibration is probably not the main or sole source of trouble; metallurgical aspects should be considered.

Original castings may have had hairline cracks that became noticeable only after some attack or etching by the feedwater, perhaps during acid washing of the boiler. Such cracks tend to appear at the junction of two intersecting planes, such as junction of a vane and a shroud. Under ideal conditions of environment and material analysis, stress corrosion may be a factor. There is almost no possibility of caustic embrittlement unless the water is actually high-pH boiler water and not normal feedwater. Effects of cavitation should also be considered.

If the metallurgical cause is eliminated and vibration is to be pursued, there are several factors to consider. Large mass of the heavy pump casing bolted to a grouted bedplate is not going to be easily moved by a much lighter rotor. Vibration readings taken on a casing or bearing housing have little significance. Readings must be taken on the shaft between stuffing boxes and bearings, both horizontally and vertically. Simplest way to do this: hold a notched wooden stick against and perpendicular to the shaft. End of the stick away from the shaft supports vibration-displacement indicator.

E H FRY, *Phillipsburg, N.J.*

Which water-chemistry tests for us?

We have several closed-cycle cooling towers in our plant to supply process cooling. Our plant is located in the Southwest in an area not noted for its pure water.

Because of local water conditions I have been very careful to monitor all possible water indicators. This includes measurements of calcium and magnesium hardness, alkalinity A, B and C, total solids by conductivity, pH, dissolved O_2 and CO_2. In addition I have been checking the Langelier-equation index once a day.

My problem is one of economizing on effort. I must cut down the number of measurements I take. So, I would like to hear from other POWER readers concerning measurements they feel are most important.

Our cycle makeup runs about 3%. Makeup water contains 250-ppm calcium, 150-ppm magnesium, 140-ppm sodium, runs an alkalinity of 200, chloride content of 200, sulfate of 100, silica of 50 and a pH of 7.8. Can any reader help out?—*FBL, May* POWER

Solutions . . .

Routine control is simplified by wise use of pH and total dissolved solids

FBL can simplify his routine control by just using pH and total dissolved solids as indicators.

Assuming the makeup comes from a well supply of fairly constant composition, analysis of the circulating cooling water after several concentrations will be roughly proportional to that of the makeup.

Once he has determined, from Langelier-Index calculation, optimum pH and solids concentration to maintain equipment free of scale and corrosion, a daily check of conductivity and pH is sufficient to show conditions in the system. More complete analyses can be run once a week, or even once a month for a periodic check.

The Langelier Index is only an *indicator* of either scaling or corrosive conditions. The significance of the actual numerical value obtained depends upon the calcium concentration, total dissolved solids, pH of cooling water and operating temperatures in the heat-exchanger units. A positive index means that scale formation will occur, provided calcium solubility is exceeded at the operating temperature in the equipment being cooled. Calcium solubility, however, is influenced by alkalinity and total dissolved solids. A negative index, combined with low calcium or dissolved solids, may mean corrosion unless protective measures are taken. This is especially true if oxygen is present at high temperature.

Based on these factors, increase in pH, conductivity or both indicates increased scale-forming *tendency*. Conversely, a lower pH or conductivity value warns of the possibility of corrosion. *FBL* should be able to correlate data from his past test records with maintenance experience on heat exchangers in order to determine optimum conditions for his system.

FBL reports he is using about 3% makeup. This equals about 30 concentrations of solids in the cooling water, which seems high in view of the makeup-water analysis. To avoid scale I would expect a makeup of 10% or more on this high-hardness high-alkalinity high-solids water. It would be interesting to know if a scale problem has been encountered. If so, *FBL* should try to keep calcium and solids concentrations down by increasing the blowdown and using an acid feed, if necessary, to adjust pH.

Finally, it should be noted that system monitoring can be simplified by installing conductivity and pH meters and recorders. Manual testing is then avoided except for periodic calibration checks and complete analyses.

G APFEL, *Ramsey, N.J.*

Test for pH, conductivity and chromate

FBL can sure cut down on the number of tests. For example, dissolved oxygen and carbon dioxide are of no significance in the circulating cooling water because saturation continuously takes place across the tower.

Makeup is 3% but the temperature drop across the tower is not given. Assuming this is 10 F, cycles of concentration will only be 1½. The Langelier Saturation Index at 1½ cycles and 105 F is +0.8 and the Ryznar Stability Index is 6.2. This is somewhat scale-forming with respect to calcium carbonate.

With a water of this type, however, there is a greater likelihood that magnesium silicate or calcium silicate will be the most troublesome encrustant. It looks like the best solution is to soften the makeup, maybe on the hydrogen-sodium cycle for alkalinity control. Sodium cycle with acid addition is also a possibility. In either case, analytical determinations can be restricted to pH, conductivity and chromate, if this is the inhibitor used.

W F DEVENNEY, *Springfield, Pa.*

Hardness-to-chloride ratio is helpful

There appears to be enough data recorded on the recirculated water. Amount of testing can certainly be decreased to save time. I would suggest that chloride and total hardness determinations be made on the makeup supply and the recirculated water. Chloride test will indicate concentration of mineral matter carried. Total-hardness test indicates whether or not scaling is occurring. The ratio of total hardness to chlorides will serve as an indicator of operating conditions. There is also a definite need for pH measurement and control.

W GRAY, *Lansdale, Pa.*

Langelier Index has many limitations

It is not necessary for *FBL* to conduct determinations for calcium and magnesium hardness, alkalinity, dissolved oxygen and carbon dioxide. These characteristics of both raw water and recirculating cooling water may vary from day to day or even hour to hour. But we do know that satisfactory mechanical condition of heat-exchange surfaces, from the standpoint of both corrosion and scale, can be maintained independent of these values.

The Langelier Index's principal value is its ability to forecast direction water properties will take. Daily calculations should show no appreciable Index change unless some outside chemical influence is exerted on the system. But it can be shown that there are as many variations in the Langelier Index in a particular system as there are temperature changes in that system. And this is only one of several variables influencing the Langelier equation.

Instead, *FBL* should control cycles of concentration in the system based on total dissolved solids. Cycles of concentration should be limited to an average value of 3. In addition, pH should be controlled in the range of 6.8 to 7.2 by adding sulfuric acid. A third test should be conducted to control whatever corrosion inhibitor is used. If raw water is not allowed to concentrate more than three times, and if pH is maintained as close as possible to neutral, only additional test required is the one to insure presence of adequate corrosion inhibitor.

C B BREAUX, *Philadelphia, Pa.*

Your August problems

What caused our "woodworm" failure?

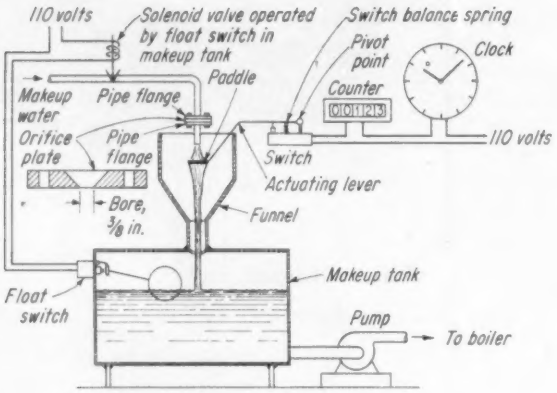
Our plant has a small high-speed water-cooled industrial gasoline engine. After 1500 hours of operation the engine was taken off the line with rings broken from overheating. During overhaul we found two other failures shown on the photograph. First, there is definite evidence of erosion around the oil outlet. Second, the babbitt lining has been removed in an irregular pattern right down to bare metal. It actually looks like the ring has been attacked by woodworms. There was no other evidence of scoring. We used SAE 30 for about 1000 hours and SAE 10 W 30 with detergent for about 500 hours. I'm hoping POWER readers will have an explanation for this "woodworm" failure and can tell us how to prevent it from happening again—*EWT*

How can we reduce gear-pump wear?

In our plant we have four rotary gear pumps operating on liquid ammonia. They take suction from a low-pressure receiver and pump ammonia to various locations throughout the plant. These pumps went into operation last February and since then we have been replacing gears almost as fast as purchasing gets them on order. We believe that the lubricating properties of liquid ammonia are not good enough to prevent these gears from running together and wearing. The pump designer doesn't agree, but doesn't seem to have a solution, either. Perhaps some reader can tell us the reason behind this excessive gear wear and suggest how we can increase gear life.—*JW*

Sit down right now and answer one or both problems. We'll pay extra for answers with photos or sketches

Timely **practical ideas** to help solve



This gadget measures raw boiler water

Our small natural-gas-fired fully automatic boiler supplies steam to a heat exchanger for hot water and to the humidifiers in our air conditioners. Soon after installation I found that water treatment could not be held within limits. We had to find a way to determine the amount of makeup water being used, to let us adjust the system so we could slug-feed the chemicals to our boilers.

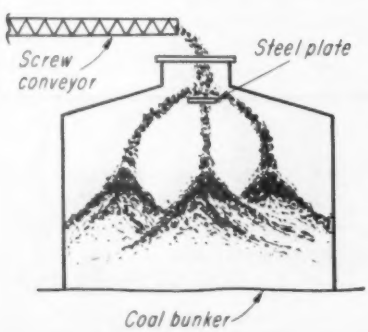
Having no instruments about the plant, I fitted an orifice to the makeup-water line and calibrated same. Next I wired a switch (with a paddle) to an electric clock and counter.

Here's how this system works: (1) Makeup tank is pumped down until it calls for more water via float-control switch. (2) Solenoid-operated valve opens and water flows through the orifice. This actuates the paddle to close the switch circuit. (3) Circuit closing steps the counter one unit and the clock starts. (4) Makeup tank fills up and float switch cuts off makeup. This in turn cuts off clock switch. The counter was necessary as orifice plate was calibrated based on sporadic flows. It is a great help.

Boiler returns were not considered —we were only concerned with the raw-water quantity. Using this jury rig, we find it's relatively simple to determine amount of raw water.

A MUIR, *Covina, Calif.*

Square steel plate distributes segregated coal



Our two 30,000-lb-per-hr chain-grate-stoker-fired boilers were fed from circular bunkers by conical nonsegregating distributors. A screw conveyor transported the coal from a bucket elevator to fill the bunkers. Stoker manufacturer recommended 1¼-in. x 0 coal with not more than 40% fines. But our unsuspecting purchasing agent, not realizing the importance of proper sizing, decided to buy 2½-in. x 0 coal to save some money.

It's not hard to guess that segregation in the bunkers was our problem. The size range was too wide to begin with, the coal was transported in a naturally segregating screw conveyor, and the piled coal showed high segregating tendencies. True, conical distributors are nonsegregating. But this coal was already segregated, and distributors won't do a thing about mixing it. They simply deliver it to the grate in precisely the same condition it leaves the coal bunker.

What to do? This 6-months' supply of coal was making our boilers impossible to fire. First thought: buy a crusher and run the coal through it. But that would cost more money!

Finally we solved the problem, simply and quite economically. Our solution was based on the fact that when coal piles up all the lumps go to the outside of the pile and the fines go to the center. The discharge in the bunker from the screw conveyor was doing just that. But we reasoned that if we had four distinct small piles in the bunker instead of just one big one, the distribution would tend to even out.

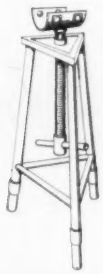
We suspended a 2-ft-sq piece of ¼-in. mild-steel plate on ½-in. rods in the middle of the coal stream discharging from the conveyor. It was about 3-ft below the conveyor and slightly to one side of bunker's center line, sketch. A pyramid of coal that tends to keep itself centered in the coal stream builds up on this plate. This, in turn, gives us four streams, one from each side of the plate, to make the four small distinct piles. This is no substitute for a crusher but it enabled us to live with that coal for six months.

We tried other shapes for the distributor plates—a right circular cone, a truncated cone, a circular flat plate and so on, but always came back to our first idea: a square flat plate.

L A WATSON, *Atlanta, Ga.*

your tricky design and maintenance problems

By STEVE ELONKA, Associate Editor



Handy pipe jack

I made a pipe jack, sketch, for installing long lengths of heavy piping which had to be hung in close quarters. Our job was to hang a steam return line from brackets in a long tunnel. There was a lot of piping to hang, so four jacks saved us time: we could weld several lengths of pipe at once by rolling them in the saddle of these jacks. Then, after they were welded in this easy-to-get-to position, hanging was no problem. These jacks also gave the right pitch to the line while it was being anchored to the wall of the tunnel.

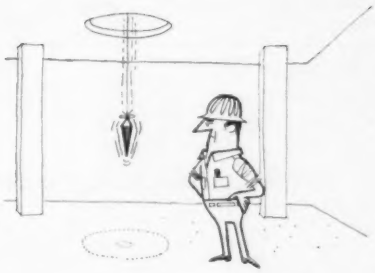
Saddles are made to suit our pipe size. The jack parts are scrap metal. The screw is made of a length of 1½-in. pipe with a continuous thread, threaded through the coupling. Coupling is welded stationary to the supporting plate on jack's table. The saddle has four large balls from an old ball bearing so the pipe rolls easily while being welded.

Extensions can be added to the legs to fit jobs of various heights.

W H JONES, *Columbus, Ohio*

Visiting New York?

If so, come and see one of the most complete bookstores in the U. S. It has just opened on the main floor of the big green McGraw-Hill building, 330 W 42nd St, only one block west of New York's famous Times Square. Not only are McGraw-Hill books handled, but all major technical and trade books, so you can inspect the latest volumes, all in one place, every time you visit exciting Manhattan.



What would you have done?

Years ago we had the job of burning pilot holes through each floor of our tall plant building during construction, from the top floor down. The plumb bob was suspended from the roof. As the top-floor hole was burned, the millwright lowered the plumb bob through the hole to the next floor, so he could mark the next hole underneath.

When the last hole had gone through using this procedure, the millwright stood on the main floor waiting for his bob to stop swinging. But because of wind and vibration, the 100-ft-long line wouldn't behave. While he waited impatiently, it kept on swinging.

Finally, the millwright went to the machine shop and had a heavier bob turned out. But when I passed him that afternoon, he was still waiting. Only this time he had a third bob. It must have weighed all of ten pounds. He was disgusted, to say the least.

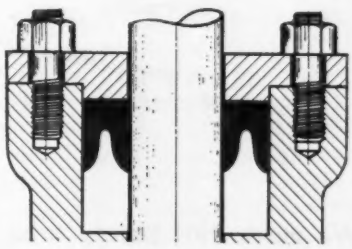
"Why don't you suspend it in a bucket of heavy oil? That should dampen your dancing bob," I suggested. He did—and the bob hung perfectly still. What would *you* have done?

G C LEWIS, *North Burnaby, B.C.*

No more gland adjustments

Here's a new hydraulic seal that needs no attention. It is a single, endless, jointless ring made of fabric-reinforced neoprene. This seal is adaptable to any stuffing-box depth from 1½ in. on up. It seals hydraulic equipment from zero to maximum operating pressure without weeping at low pressure or leaking at high.

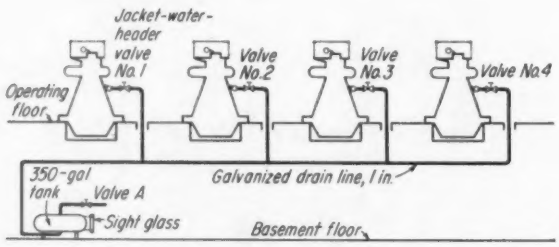
Seal's design gives it inherent strength and sensitive response to varying pressures. The vertical jointless-ply construction features maximum strength plus resiliency. Massive top construction withstands packing shock from press "bumping" which would probably deform conventional



U-rings or nested-ring packings.

The flared-lip design tightly seals both stuffing-box wall and the surface of the ram at all pressures. Because material is neoprene, it won't swell, soften or deteriorate because of exposure to oils or to greases.—*Courtesy, E I du Pont de Nemours and Co, Wilmington, Del.*

More **practical ideas**



Our jacket-water drain system saves treated water

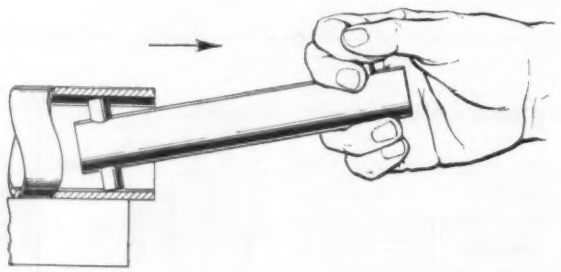
No provision had been made for storing jacket water during maintenance to the four diesels at a public utility plant. All the treated water was lost when repair work was done. This ran up the cost of water-treating chemicals, took costly man-hours refilling the jackets and treating the water. To save treated water, we installed a 1-in. line draining from each engine to a basement storage tank.

All valves are closed. First the valve at the water header of the unit to be drained is opened, then valve *A*. When the unit has drained, as seen on the tank's sight glass, valve *A* is closed. Then maintenance men can get to work on the diesel engine.

To refill the unit, an air hose from 40-psi regulated air supply is connected to the line at valve *A*. This valve is opened, and air pressure forces the water back into the engine jacket. When the sight glass shows the storage tank to be empty, the valve at the unit is closed, the air line removed and valve *A* closed. Unit drains in seven minutes; it takes another seven minutes to refill the jacket; then engines can be started.

Installation cost $400, including the time of plant personnel who did the work. In three years of operation, the system has paid for itself many times over, any way you look at it.

A A Flower, *Scott City, Kan.*



We made this handy tube puller

When tubing is stored in a rack and must be pulled out endwise, it's not easy to get a good grip, especially if the surfaces are oily. We made a simple tool which has proved helpful for long condenser tubes, sketch.

We drilled holes in each end of a short length of pipe, then drove a pin through each hole. Pins at each end are of different lengths so that two different sizes of tube can be handled —they're about 1/16-in. longer than ID of the tubes.

To use the tool, we insert it in the tube at a slight angle, then pull it down so the pin wedges. Pin on the outer end gives a good hand-grip.

L Kasper, *Philadelphia, Pa.*

My biggest boner

As an engineering assistant in one of the company's power plants, I had the duty of aiding our research department. One time we were going to test the tubes of a small condenser on the mezzanine floor. This floor was just as devoid of convenient 110-v-ac outlets as was the turbine-room floor above.

In searching for an outlet into which I could plug the small transformer, I extended a cord from a gage board down through a grating to the mezzanine floor. After further searching I decided that maybe the l-p-section gage boards had a convenient outlet in the rear. I opened the rear door and there was one.

I went down to the mezzanine floor and plugged the research department's transformer into the outlet on the end of the extension cord. As I stood there, alarms began to whistle and boiler safety valves popped. There was a great deal of scurrying by operating personnel as they tried to right whatever happened that was wrong. Wow! What a scramble.

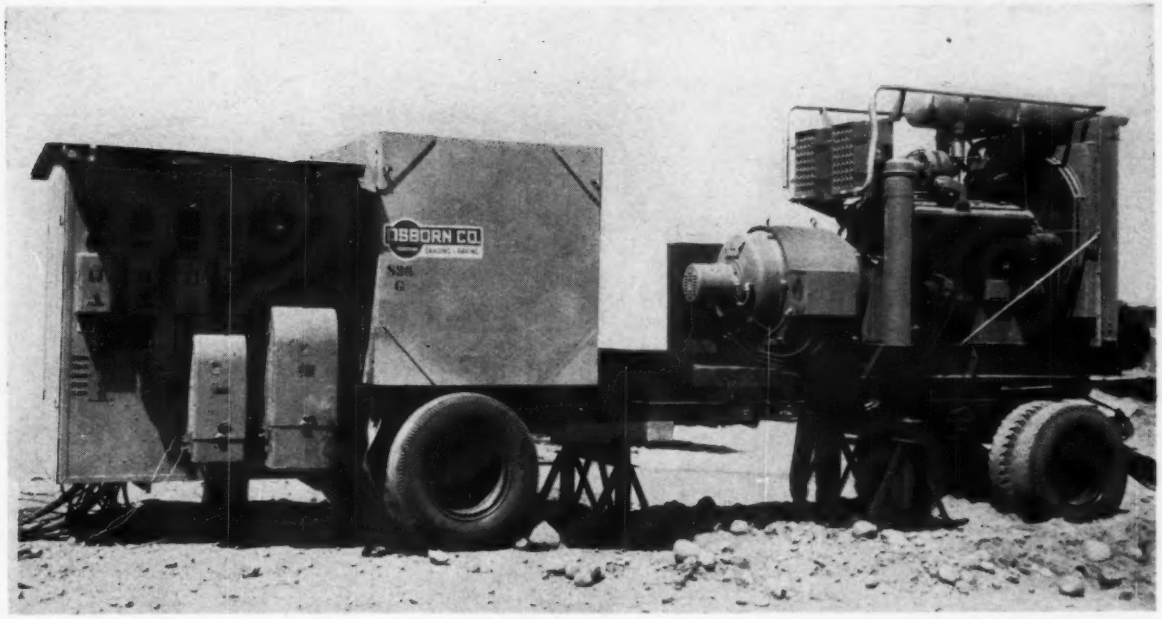
Somehow, I realized that my extension cord was the cause. I ran up and unplugged it after first unplugging the transformer.

When things had calmed down a post-mortem was held. None of the operating personnel could understand why the unit had suddenly dropped a percentage of its load. I then mentioned what I had done. I learned that the three l-p units each had an unloading device and this outlet, used in the early days to test the unloader, had never been removed.

I have since used more caution when poking into a strange place.

L K Kane, *Livonia, Mich.*

MOBILE ELECTRIC-GENERATOR SET is completely self-contained. All auxiliary equipment, fuel tank and load-control panel mount permanently on the trailer. On location, separate supports under the trailer frame steady the entire unit and minimize vibration



Trailer-mounted diesel generator supplies 300 kw of power where you need it

At isolated construction sites, electric-power requirements are on the increase. Short-term needs and long line distances make utility connections too expensive

By C R HAVIGHORST, Senior Technical Editor
McGraw-Hill World News, Los Angeles

The Osborn Company operates a mobile hot-mix asphalt plant in the Southwest, and to minimize hauling distance, the plant is frequently on the move. Electric-power needs are high, approaching 300 kw during plant startup; individual motors run up to 100 hp to operate the drum dryer, rotating screen, elevator and many other equipment items. Since the plant moves as the job progresses, it would be prohibitively expensive to run utility power lines in to each location—and the predicament is, of course, aggravated by remote plant locations, often far from existing lines.

To meet this special problem Osborn bought a completely self-contained diesel-generator set, mounted on a trailer. Total unit cost about $25,000. Compare this with utility-system connecting costs as high as $4000 each time the asphalt plant has to move on to another location.

Basic diesel-generator set is made up of a 12-cylinder V-type 600-hp engine running at 1800 rpm to drive the 300-kw generator. Engine itself weighs 15,000 lb. Necessary auxiliaries are also mounted on the trailer, including a 1000-gal fuel-oil tank and the output load-control panel, which is overhung from the rear of the trailer. Fuel consumption: 24 gph at full rated load.

Engine is electric-started from a 24-v storage battery, but there is no reason why starting couldn't be done by a small direct-connected gasoline engine. Connected load—450 amp at 480 v—is essentially the generator's normal loading, but it will operate at an overload for two hours without undue heating. Hydraulic governor maintains synchronous speed within ± 3% from no load to full load. Automatic controls shut the engine down if cooling-water temperature rises above 205 F or if oil pressure drops below 20 psig.

The dust-laden air which usually surrounds such a plant poses no hazard to this turbocharged engine, equipped as it is with two 48-cone cyclonic-effect filters. They centrifugally separate heavier dust particles from the induced air flow. Then the partially cleaned air goes through paper filters which make it clean enough for the engine intake. Manometers, indicating pressure drop through the filters, tell when they should be serviced.

9 billion dollars to build a better one.

We're living in a needing, buying, growing America—a time for new and improved products and services—the creation of new jobs. More than ever, a businessman with an idea, with the urge for something better will move ahead with our expanding economy.

But after the idea, what follows can be a costly period of research and development. Not necessarily—if you use the immense 9-billion-dollar fund of research and patent information that's available at your U.S. Department of Commerce. Think of the saving—in time and money.

For example: there are reports on extensive research by your Government in new products and processes. A translation of data on inventions and discoveries abroad—information on over 3 million patents—a fortune in patents owned by your Government. All this is yours—for your use and your benefit.

Take advantage of the many ways in which your business can grow. In developing new products and services. In the lucrative foreign markets. In new U.S. markets. In attracting new industry to your local community. Just phone or write the U.S. Department of Commerce Office of Field Services in your city, or Washington 25, D.C. Your U.S. Department of Commerce is always ready to help you grow with America!

NOW'S THE TIME TO GET GROWING IN A GROWING AMERICA!

PROFESSIONAL SERVICES

BLACK & VEATCH

Consulting Engineers

Electricity—Water—Sewage—Gas—Industry
Reports, Design, Supervision of Construction
Investigations, Valuations and Rates

1500 Meadow Lake Pkwy, Kansas City 14, Missouri

BURNS & McDONNELL

Engineers — Architects — Consultants

4600 E. 63rd S. Trafficway
Kansas City 41, Missouri

GILBERT ASSOCIATES, INC.

Engineers and Consultants

Design and Construction
Engineering and Economic Studies for
Thermal, Hydro and Nuclear Power
Industry • Water and Sewage

New York READING, PA. Washington

INTERNATIONAL ENGINEERING COMPANY, INC.

Engineers

Investigations — Reports — Design
Procurement — Field Engineering
Domestic and Foreign

74 North Montgomery St., San Francisco 5, Calif.

PETER F. LOFTUS CORPORATION

Design and Consulting Engineers

Electrical • Mechanical • Structural
Civil • Nuclear • Architectural

First National Bank Building
Pittsburgh 22, Pensylvania

CHAS. T. MAIN, INC.

CONSULTING ENGINEERS

Design—Construction Management
Steam, Hydroelectric & Diesel Plants
Gas Turbine Installations
Transmission—Distribution

Boston, Mass. Charlotte, N. C.

PIONEER SERVICE & ENGINEERING CO.

Consulting & Design Engineers
Purchasing
Construction Management

231 So. La Salle St. Chicago 4

SARGENT & LUNDY

ENGINEERS

Consultants to the Power Industry

STUDIES • DESIGN • SUPERVISION

140 South Dearborn Street, Chicago 3, Ill.

J. E. SIRRINE COMPANY

Engineers Since 1902

Consultations • Design • Reports
Steam & Hydro Power Plants
Steam Utilization
Laboratory Analyses of Water

Greenville, South Carolina

ALDEN S. STILSON & ASSOCIATES

Consulting Engineers

Industrial & Municipal Power Plants
Surveys, Reports, Design & Supervision

Columbus, Ohio Cleveland, Ohio

TIPPETT & GEE CONSULTING ENGINEERS

Mechanical—Electrical—Thermodynamics—Structural
Design—Studies—Supervision
Power Stations—Transmission—Distribution
Industrial Plants—Process

1333 North Second Street Abilene, Texas
214 Meadows Building Dallas, Texas

CLASSIFIED SEARCHLIGHT SECTION ADVERTISING

EMPLOYMENT • BUSINESS • OPPORTUNITIES • EQUIPMENT—USED or RESALE

DISPLAYED RATE

The advertising rate is $20.50 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

EMPLOYMENT OPPORTUNITIES — $52.00 per inch subject to agency commission.

INFORMATION:

DISCOUNT OF 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

An ADVERTISING INCH is measured ⅞ inch vertically on one column, 3 columns—30 inches—to a page.

UNDISPLAYED RATE

(Not available for Equipment Advertising)
$2.10 a line. Minimum 3 lines. To figure advance payment count 5 average words as a line. (See ¶ on Box Numbers.)
POSITION WANTED undisplayed rate is one half of above rate, payable in advance.
BOX NUMBERS count one additional line.

Send New ADS or Inquiries to Classified Adv. of Power, P. O. Box 12, New York 36, N. Y.

DESIGN OPPORTUNITY

We need a creative electrical design guyed engineer for advanced work on guyed tower and other transmission structures of large power systems.

If your knowledge, ability, record and practical experience meet requirements, major manufacturer is ready to add to staff.

Write for interview:

P-7001, POWER
255 California St., San Francisco 11, Calif.

MECHANICAL ENGINEERS

Immediate opening for Project Manager and Project Engineer experienced in design of power plants; piping; and heating, ventilating, and air conditioning. Extremely wide variety of work with established Midwest consulting firm. Permanent. Good starting salary, advancement, and vacation program. Moving expenses paid. Send complete resume to
P6349, POWER
520 N. Michigan Ave., Chicago 11, Ill.

WHEN *Answering Advertisements* PLEASE *do not send original letters, certificates or photographs. We cannot be responsible for their return. Please send photostat or carbon copies.*

COMBUSTION ENGINEERING, INC.

One of the world's foremost producers of steam generating and fuel burning equipment is moving its largest research and development facility from Chattanooga, Tennessee, to the site of its general offices in

WINDSOR, CONNECTICUT

CHALLENGING CAREER OPPORTUNITIES ON KEY PROJECTS ARE AVAILABLE TO:

- Water and coal analysts and technologists
- Research and development engineers
- Mechanical engineers
- Chemical engineers
- Stress analysts
- Heat transfer specialists
- Librarian

All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

Submit detailed resume and salary requirements to

S. G. Shepard, Personnel Department
COMBUSTION ENGINEERING, INC.
Prospect Hill Road, Windsor, Connecticut

EMPLOYMENT OPPORTUNITIES

(Con't. from page 197)

IMMEDIATE OPENING FOR STAFF ENGINEER

Position with International Electrical Trade Association located in Midwest. Work entails minor electric motor design, writing of short articles, public speaking, approximately 15% travel and general consulting for repair of electric motors and generators. Prefer experienced man with degree in electrical engineering. Send resume to

P-7073, POWER
645 N. Michigan Ave., Chicago 11, Ill.

SALES ENGINEERS

Leading Water Treatment Company has several openings in key territories. Chemical background or power plant experience required. Write to:

Power Chemicals Division
E. F. DREW CO., INC.
15 E. 26 St., New York 10, N. Y.

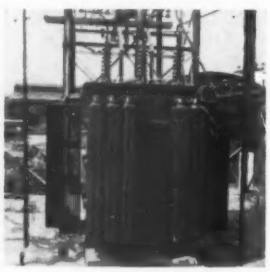
ADDRESS BOX NO. REPLIES TO:
Box No. Classified Adv. Div. of this publication.
Send to office nearest you.
NEW YORK 36: P. O. Box 12
CHICAGO 11: 645 N. Michigan Ave.
SAN FRANCISCO 11: 255 California St.

POSITIONS WANTED

Hydro-Plant Operator—8½ years experience in operation and maintenance. Age 40—will move anywhere. PW-7066, Power.

1st Class Steam Engineer, 33 married, three children, desires position abroad in industrial or utility plant. 16 yrs. varied experience, last 8 with large chemical plant. H. M. Lavender, 11053—107 St., Edmonton, Alberta.

Power Plant Engineer, age 34, experienced in new plant start up, operation, maintenance, supervision. U.S. or overseas. PW-7082, Power.



(1) 7500 KVA **Westinghouse Transformer**—1948. Primary 69300/67650/66000/64350 Volts—Secondary 13800 Volts, 3 Phase, 60 Cycle type—SL, Class OA, Imp 8.4%—S/N 4089566 complete with overhead structure, bushings, strain insulators, fused disconnects, etc.

Liquidating former Phoenix Steel Corp. Plant at Harrisburg, Pa. Dozens of other transformers 2400 Volt Primary 220/440 secondary 60 Cycle—666 KVA to 25 KVA.

AT FRACTION OF REPLACEMENT PRICE

WRITE — PHONE — WIRE

LIPSETT DIVISION
Luria Brothers & Company, Inc.
915 South Front Street
Harrisburg, Pa.

CEDAR 6-5988
Arnold C. Landesberg—Project Manager

Circle 500 on Reader Service Card

COMPLETE STEAM POWER PLANT

NORTH LITTLE ROCK, ARKANSAS

(5)—Combustion Eng. Co. 435 HP, 4620 sq. ft. water-tube boilers, 3-drum low-head, 300 PSI, 24,500 lb. Saturated Steam per hour. Gas fired, with oil stand-by system. Built 1943, used very little. *Can be Sold or Leased on Site.*

PERRY EQUIP. CORP.
1422 N. Sixth St.
Philadelphia 22, Pa.
POplar 3-3505

Circle 501 on Reader Service Card

FOR SALE TO HIGHEST BIDDER

Seven 450 HP duplicate
DIESEL GENERATOR SETS
One at a time or all at one sale.

Excellent condition
Still on foundations in Western Canada.
Engines—Fairbanks 32E14—300 RPM 14x17
Generators—375 KVA 3/160/4160—2400 volts
Cost $46,000 each—4 in 1941—3 in 1951
Also $86,000 worth of repair parts

SOUL CLINIC, INC.
815 8th Ave., West, Calgary, Alberta, Can.

Circle 502 on Reader Service Card

COMPRESSORS

No better values at any price

100 CFM	150 PSI 6x7 Ing. ES-1
138 CFM	100 PSI 7x7, Ing. ES, CP & Jay
258 CFM	500 PSI 9½-4¼x11 Ing. ES2 (New)
288 CFM	100 PSI 9x9 Ing. Worth. CP
321 CFM	125 PSI 10x11 Ing. ES-1
344 CFM	1500 PSI Ingersoll ES-3
380 CFM	40 PSI 12x9 Gard. (New) Ethylene
456 CFM	350 PSI 12-6x13 Worth HB2
465 CFM	100 PSI 12x11-1R-ES-I" Chic. P.T.
502 CFM	125 PSI 12x13 Worth HB
676 CFM	125 PSI 15-9¼x12 Ing. XRE 125 Syn. 3-60-440-277 RPM
686 CFM	100 PSI 14x13 Ing. ES
1855 CFM	100 PSI 23-14x14 Ing XRE 300 HP GE Syn 3-60-440 (2) 1952
2200 CFM	110 PSI 26/15x18 Chicago Pneumatic OCE .8PF 350 HP Syn. 3/60/4160

AMERICAN AIR COMPRESSOR CORP.
48th & P, North Bergen, N.J. UN 5-1397

Circle 503 on Reader Service Card

FOR SALE

USED KEELER CP BOILERS

Two Units, each 15,000#/hr., shop assembled (design pressure 160 psi, heating surface 1,630 sq. ft.). Equipped with Indiana Heavy Oil Burners, Pratt-Daniel ID Fans and Stub Stacks, Normal Trim and Republic Feed-water Regulator. Units located in St. Louis Area, and are five years old.

F. S. CROOK, INC.
1004 Market Street
St. Louis 1, Mo.

Circle 504 on Reader Service Card

DIESEL ENGINE

1 HEAVY DUTY NORDBERG

Type TSM—model 32118—1700 HP @ 180 RPM — 21½" x 29". Unit complete with all pumps and coolers. Can be used for generator drive, producing 2400 HP @ 225 RPM. Equal to new. Presently in Maritime Academy.

THE BOSTON METALS CO.
313 E. Baltimore St., Baltimore 2, Md.
ELGIN 5-5050 — LEXINGTON 9-1900

Circle 522 on Reader Service Card

Searchlight Equipment Locating Service

No Cost or Obligation

This service is aimed at helping you, the reader of "SEARCHLIGHT", to locate Surplus new and used power equipment not currently advertised. This service is for USER-BUYERS only. How to use: Check the dealer ads to see if what you want is currently advertised. If not, send us the specifications of the equipment and/or components wanted on the coupon below, or on your own company letterhead to:

SEARCHLIGHT EQUIPMENT LOCATING SERVICE
Classified Advertising
c/o POWER
P.O. Box 12, N. Y. 36, N. Y.

Your requirements will be brought promptly to the attention of the equipment dealers advertising in this section. You will receive replies directly from them.

SEARCHLIGHT EQUIPMENT LOCATING SERVICE
Classified Advertising
c/o Power,
P.O. Box 12, N.Y. 36, N.Y.

Please help us to locate the following used equipment:

.....

.....

NAME .....

TITLE ..... COMPANY .....

STREET .....

CITY ..... ZONE ..... STATE .....

8/61

LIKE NEW . . . RECTIFIERS AT 75% OFF COST

FOUR 1100 KW ALLIS-CHALMERS MERCURY ARC RECTIFIERS total 4440 KW, 16000 Amp, 3/60/33000/4160/2300 to 275-86 Volts complete with Automatic Controls • 4—1320 KVA OISC Transformers 3/60/4160-277 Volts with Interphase Reactors • 2—4475/6925 KVA OA/FA REGULATING TRANSFORMERS 3/60/33000—4160 with 2300 tertiary winding and remote controlled tap changers.

Above Complete on Foundations **Can Be Purchased Individually**

Complete Specifications & Blueprints Available

HEAT & POWER CO., INC.

60 EAST 42nd ST. NEW YORK 17, N. Y. MU 7-5280

Circle 505 on Reader Service Card

OPPORTUNITIES!

in

New and used equipment recently released from service by a number of electric and gas utility companies

POWER PLANT EQUIPMENT
CONSTRUCTION EQUIPMENT
SUBSTATION EQUIPMENT
TRANSMISSION LINE MATERIALS

Send for new list . . . to

EBASCO SERVICES INCORPORATED
APPARATUS EXCHANGE
Two Rector St., New York 6, N. Y.

Circle 509 on Reader Service Card

A. C. MOTORS—60 CYCLE

HP	Mfr.	Type	Volts	Speed
800	Whse. (2)	Sq. Cage	2300	1800
750	El. Machy.	Synch.	480	514
700	G.E.	Slipring	2300	400
700	G.E.	Slipring	2300	514
600	G.E.	Synch.	480	900
600	Elliott (2)	Sq. Cage	2300	900
500	G.E.	Slipring	2300/4000	514
500	Al. Ch. 3 brg.	Slipring	440	514
500	G.E. b.b. (2)	Synch.	2300/440	1200
450	Allis Ch.	Sq. Cage	2300/440	720
400	Whse.	Sq. Cage	2200	514
400	Marathon (2)	Sq. Cage	2300	3600
400	G.E.	Slipring	2200/440	600
400	G.E.	Synch.	550/2200	400
400	Whse.	Sq. Cage	440	1200
350	G.E.	Slipring	440	900
350	El. Machy.	Synch.	2300	900
300	G.E.	Slipring	220/440	514
250	G.E.	Sq. Cage	440	1200
250	Gen. Elec.	Sq. Cage	440	3600
250	Whse.	Sq. Cage	2300/440	600
250	Whse. (4)	Slipring	2300/440	600
200	G.E.	Slipring	550/440	1200
200	Gen. Elec.	Synch.	550/440	400
200	G.E. b.b.	Sq. Cage	220/440	720
200	G.E.	Slipring	220/440	450
200	G.E.	Slipring	440	600
200	G.E.	Slipring	2200	900
200	Reliance b.b.	Sq. Cage	220/440	1800
200	Allis Ch.	Slipring	2200/440	720
200	G.E.	Sq. Cage	2300	450
150	Reliance	Sq. Cage	220/440	900
150	Whse. b.b.	Sq. Cage	440	1800
150	Whse. XP	Sq. Cage	440	3600
150	G.E. (4)	Slipring	2200/440	600
150	Whse.	Slipring	220/440	1200
150	G.E.	Sq. Cage	2200/440	600
125	Star b.b.	Sq. Cage	220/440	900
125	A.C. TEFC	Sq. Cage	220/440	1800
125	El. Machy (2)	Synch.	220/440	400
125	G.E. TEFC	Sq. Cage	2200	3600
125	Al. Ch. TEFC	Sq. Cage	220/440	600
125	G.E. (2)	Slipring	220/440	514
125	Whse. b.b.	Sq. Cage	220/440	3600
100	Star b.b.	Sq Cage	220/440	600
100	Allis Ch.	Slipring	2300/440	600
100	Al. Ch. TEFC	Sq. Cage	2200	1800
100	G.E. TEFC	Sq. Cage	220/440	1200
75	A.C. TEFC	Sq. Cage	2300/440	1200

D. C. MOTORS

HP	Mfr.	Type	Volts	Speed
350	G.E.	MPC	250	900/1200
250	Cr. Wh.	101-H	230	1150
200	Whse. b.b.	SK	250	287/575
150	Reliance b.b.	1050-T	230	1150
150	Rel. TEFC b.b.	2850-F	230	850
125	G.E.	CD-173	230	575/1150
100	Elliott b.b. T.E.	JH-FE	230	1150
100	El. Dyn. b.b. (2)	30-S	230	450/1200
75/100	Whse.	SK-191	230	300/900
75	Reliance b.b.	385T	230	850/1700
60	G.E. TEFC b.b.	CD-138	230	1150
40/50	Whse. b.b.	SK-173	230	300/1200

MOTOR-GENERATOR SETS

KW	Mfr.	Input V	Output V
600	Allis Ch.	440 AC	250 DC
300	G.E.	440 AC	250/330 DC
200	Allis Ch. (2)	440 AC	250 DC
200	Whse. synch.	220/440 AC	55 DC
200	Gen. Elec.*	220/440 AC	125 DC
100	Delco b.b.	220/440 AC	120/240 DC
75	Whse. Synch.	220/440 AC	250 DC
75	Elec. Prod.	220/440 AC	125 DC
50	G.E.	220/440 AC	250 DC

Arthur Wagner Co.
Certified
MOnroe 6-7409
1435 W. RANDOLPH ST
CHICAGO 7, ILLINOIS

Circle 506 on Reader Service Card

FOR SALE

2 Westinghouse Turbo Generator Sets

312 KVA each—Initial Stm. 150 PSIG—Exhaust Stm. 5 PSIG—Electrical Conditions 3/60/2400V Surface Cond.—Westinghouse Switchboard, fully metered—New in 1947—$75,000 complete—will consider terms.

CARLETON LICHTY
Hotel Del Coronado, Coronado, Calif.

Circle 510 on Reader Service Card

WE PAY
$ CASH $
FOR
Electric Motors • Starters • Transformers
Circuit Breakers — Electric Supplies
ALLIED ELECTRIC CO.
710 N. MAIN ST. MEMPHIS, TENN.
BOX 1838 — PHONE JA 7-1681

Circle 508 on Reader Service Card

WANTED

Complete 1000 K.W. Coal Fired STEAM ELECTRIC PLANT 2300 VOLTS

BAKER COMMODITIES, INC.
4020 Bandini Boulevard, Los Angeles 23, Calif.

Circle 507 on Reader Service Card

DIESEL GENERATOR SETS—3 ph., 60 cy.

QTY	KVA	MAKE	VOLTS	RPM	YEAR
2	1000	Hamilton	2300	600	1945
2	1250	G.M.	2300	720	1945
2	250	G.M.	220/440	1200	Rebuilt '60
1	375	G.M.	220/440	1200	1945
1	413	Worth.	240	600	1949
1	150	Superior	240	1200	98% New
1	150	F.M.	2300	360	1940
1	37.5	Buda	240	1200	98% New
1	31.5	Cummins	240	1200	98% New

STEAM TURBO GENERATORS—Non-Cond.

KW	MAKE	VOLTS	STEAM	EXHAUST	YEAR
5000	G.E.	2400/4160	825#	265/20	1954
3000	G.E.	2300	200#	15	1923
3500	G.E.	2300	250#	20	1955
1000	G.E.	2300	400#	90/125	1945
1000	Elliott	480	325#	145/20	1950
750	G.E.	480/4800	165#	15	Late
300	Allis	2300	175#	3/20	1948
250	Allis	240	140#	6/20	1948
125	Allis	240	140#	6/20	1948

STEAM TURBO GENERATORS—Condensing

KW	MAKE	VOLTS	STEAM	EXTR. LB.	YEAR
5000	G.E.	2400/4160	825#	265	1954
3000	G.E.	2300/4000	250#	15	1937
3500	G.E.	4800	825#	265	1954
3000(2)	G.E.	2300/4160	400#	—	1940
1000(2)	Elliott	480	155#	—	1948
750	West.	480	175#	15	1940
600(2)	G.E.	600	150#	10	1930
400(2)	Elliott	480	175#	—	1956
200	Worth.	480	200#	50	1947

PACKAGE BOILERS

Q	HP	MAKE	W.P.	FIRING	YEAR
4	500	Cl. Bk.	200	Oil	1942
1	200	Erie	160	#6	1951
1	150	Cyclotherm	150	#6	1947
1	150	Cl. Bk	15	#6	1956
1	70	Ames	15	#2	1951

AIR COMPRESSORS

CFM	PSI	MAKE	TYPE	H.P.	VOLTAGE	RPM	YEAR
7550(2)	24/30	I.R.	XHE	600	3/60/4160	360	1948
4000	125	I.R.	PRE	700	3/60/2400	164	1946
1853	125	Worth.	DC-2	300	3/60/2300	277	1946
2000(2)	100	Fuller	Rot.	300	3/60/2300	600	1942
676(2)	125	C.P.	OCE	125	3/60/480	277	—
515(4)	125	I.R.	40	100	3/60/440	870	1940/50
404	125	I.R.	XRB	75	3/60	277	—
464	100	I.R.	ES-1	75	3/60	300	1950
368	100	I.R.	ER-1	60	3/60	277	Late

"Everything from a Pulley to a Powerhouse"

THE O'BRIEN MACHINERY CO.

R. M. REGISTERED U. S. PATENT OFFICE

• Telephone
BAldwin 8-1480
• Cable Address
OBRIEN, PHILA.

MERCHANTS—CONSULTING ENGINEERS—EXPORTERS

OFFICES IN MEXICO, BR., IL, COLOMBIA, ARGENTINA, PANAMA

Se Habla Espanól

1937 W. CLEARFIELD ST., PHILADELPHIA 32, PA.

Circle 511 on Reader Service Card

TRANSFORMERS—60 CYCLE

QU.	KVA	MAKE	TYPE	PHASE	VOLTAGE
2	3000	Moloney	TCR	3	7200-4160/2400
2	3000	G.E.	OA-T	3	26,400-4160/2400
1	1500	West.	O.I.S.C.	3	26,400-480 taps-hi
2	500	G.E.	K.S.T.Q.	1	4150-2400
1	300	Penna.	OA Askarel	3	12,470Y/7200-240
3	200	Amer.	C.C.	1	4160/7200-240/480
3	200	G.E.	H8-W2S	1	2400/4160-240/480
2	75	G.E.	H-form KF	1	2400/4160Y-120/240
1	75	West.	DS Dry	3	480/240-240/120
3	50	Niagara	Dry-air	1	2400/4160Y-120/240
3	50	Harrison	Dry-air	1	2400/4160Y-220/440

MOTOR GEN. SETS

QU.	KW	MAKE	SPEED	D.C.	A.C.
1	1000	West.	720	600	2300/4160 S.R.
1	400	West.	900	250	3 unit 4160 V. syn.
1	300	G.E.	1200	250	2300/4160 syn.
1	300	Al. Ch.	1200	125/250	3 unit 440 syn.
1	175	West.	1200	125	4160 syn.
1	100	West.	900	230	4160 syn.
1	45	G.E.	1170	30	440V Sq. Cage
2	30	G.E.	1760	230	440V Sq. Cage

D.C. MOTORS—230 VOLT

QU.	HP	MAKE	SPEED	TYPE
1	350	G.E.	1200	ped. type
1	90	G.E.	1750	CDM
1	30	West.	1750	SK-113
1	30	G.E.	2200	CD-85
1	15	Crocker Wh.	1750	CCM, TEFC

SLIP RING MOTORS

QU.	HP	MAKE	SPEED	TYPE	VOLTS
1	500	G.E.	450	MT-422Y	2200
1	450	West.	1800	CW 4-30-9	220
1	250	West.	1800	CW	2300
1	200	G.E.	1170	1-13 A	4150
1	200	West.	585	CW	440
3	150	Al. Ch.	1760	AY-RW	2300
2	150	G.E.	590	1-16	4000
1	100	West.	1770	TEFC B.B.	220/440
1	75	West.	1160	CW 607	220/440
1	75	West.	600	CW 774C	220
1	50	G.E.	570	MT 552	220/440

SQUIRREL CAGE MOTORS—3 phase—60 cyc.

QU.	HP	MAKE	SPEED	TYPE	VOLTS
1	300	Al. Ch.	1200	TRW	2200
1	300	G.E.	1806	63368 B.B. Drip	4160/2400
1	275	G.E.	1180	KT 559BS	2200
2	250	G.E.	1790	KTEFC B.B.	2300
2	150	G.E.	1780	K 6323-S XP B.B.	440
2	100	Cont.	3570	NP 585-S XP B.B.	440
1	75	Cont.	3565	NP5058X XP B.B.	440
1	75	G.E.	875	KT 552Y	440
1	50	G.E.	3530	KF 405Y Vert.	220/440
1	50	Cont.	3530	NP 445X XP B.B.	220/440

MOTORS—SYNCHRONOUS 3 ph, 60 cyc.

HP	SPEED	MAKE	TYPE	VOLTS
325	900	West.		2300
400	450	West.	HR	440
300	720	El. Mh. TEFC		2300
200/100	720/360	West.		4150
150	3600	G.E.	TS 958Y drip	2300
150	1800	G.E.	TS	220/440
150	900	West.		220/440
125	900	G.E.	TS 7536	2200
125	600	G.E.	TS 7641	2200
75	1200	Cr. Wh.	ALT B.B.	220/440

"FOR POWER"

J.L. HEMPHILL & CO.

1603 54th STREET, NORTH BERGEN, N. J.

PHONE NEW YORK—LONGACRE 5-3227

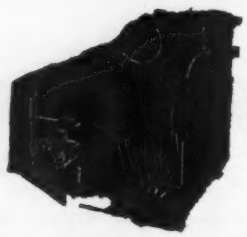
PHONE NEW JERSEY—UNION 3-2600

Circle 512 on Reader Service Card

Your Inquiries to Advertisers Will Have Special Value . . .

—for you—the advertiser—and the publisher, if you mention this publication. Advertisers value highly this evidence of the publication you read. Satisfied advertisers enable the publishers to secure more advertisers and—more advertisers mean more information on more products or better service—more value—to YOU.

BOILERS NEW UNASSEMBLED



# Steam/hr.	Key	PSI	Temp.
122,500	DF	565	850
121,650	DF	565	850
60,000	SF	435	750
74,000	H	280	500
55,000	A	240	—

DF Double Furnace, SF Single Furnace (illustrated), bent water tube boilers w/economizers and superheaters, B & W's and Foster Wheelers.

H Header type, straight tube, B & W.

A 3 drum, single furnace, Wickes.

Pelnik-Loconti Industrial Supply, Inc.

315 Oriskany St., Yorkville, N.Y.

Utica, N. Y. Ph. RE 6-4621, RE 2-4513

Circle 513 on Reader Service Card

EXCELLENT TRANSFORMERS FOR SALE

3—500 KVA PENNSYLVANIA

3—833 KVA Westinghouse transformers, Type SL, Class OA Voltage rating 55,000 to 2400 Volts, with taps below, Impedance 7.1%, Exc. Condition.

LOCATED IN ROUND MOUNTAIN, NEVADA

3—500 KVA Pennsylvania, Single phase 33,000 to 2400/4160Y, with Taps to 29,700, Subtractive Polarity 5.1% impedance, external tap changers.

LOCATED IN FREDERICKTOWN, MISSOURI

HUGE STOCK, OTHERS AVAILABLE

MACHINERY CENTER, INC.

1201 So. 6th W. P.O. Box 964

HU 4-7601 Salt Lake City 10, Utah

Circle 514 on Reader Service Card

BURY COMPRESSORS

Completely Factory Rebuilt

2. **15CFM**, 5000 Psi,—4 Stage, Air Cooled, 15Hp 220/440 Volt Portable.
1. **155CFM**, 100 psi, 8x8, **30 HP** 220/440 volt motor.
2. **700CFM** 35 psi, 11x16x14, Steam Driven.
1. **1075CFM**, 100 psi, 18x11x14, **175 HP** 440 volt Syn. Motor.
1. **1020CFM**, 100 psi, 14x14x12x14 **210HP** 2200 Volt Syn. Motor.
1. **1700CFM**, 200 psi 16x16x14x16, **300 HP** 440 volt Syn. Motor.

BURY COMPRESSOR CO.

ERIE, PA.

Circle 515 on Reader Service Card

SKINNER VERTICAL UNIFLOW

250 KVA, 480 volt, 3 phase, 60 cycle Skinner, 2 cylinder vertical used universal uniflow generating unit, steam pressure 150 to 175 pounds throttle pressure, 2 to 5 pounds back pressure.

Available for Immediate Shipment From Original Foundations in Illinois.

FRANK M. BEESON ENGINEERING CO.

1511 W. 27th St., Los Angeles 7, Calif.

RE 5-9820

Circle 516 on Reader Service Card

MODERN POWER BOILERS

1—Babcock & Wilcox	—122,000#s/hr	—250 psi
3—Combustion-Engineering	—110,000	—200 psi
1—Riley	—100,000	—456 psi
1—Babcock & Wilcox	—100,000	—450 psi
1—Babcock & Wilcox	— 90,000	—265 psi
1—Combustion-Engineering	— 75,000	—250 psi
1—Riley	— 70,000	—250 psi
2—Babcock & Wilcox	— 70,000	—450 psi
1—Riley	— 60,000	—290 psi
2—Combustion-Engineering	— 50,000	—250 psi
1—Babcock & Wilcox	— 45,000	—450 psi
1—Combustion-Engineering	— 40,000	—220 psi
1—Foster-Wheeler	— 40,000	—200 psi
1—Babcock & Wilcox	— 35,000	—300 psi
2—Riley	— 35,000	—250 psi
1—Babcock & Wilcox	— 27,500	—450 psi
2—Riley	— 19,000	—200 psi

MIDWEST BOILER & TURBINE CO.

WARNER NEW HAMPSHIRE PHONE 244

Circle 517 on Reader Service Card

AUTOMATIC and MANUAL

Gas or DIESEL GENERATOR UNITS

Complete Switchboard Design and Construction

USED & REBUILT EQUIPMENT

UNIVERSAL POWER ENGINEERING CO.

382 Wayne St. Jersey City, N. J.

Phone: DElaware 2-8300

Circle 518 on Reader Service Card

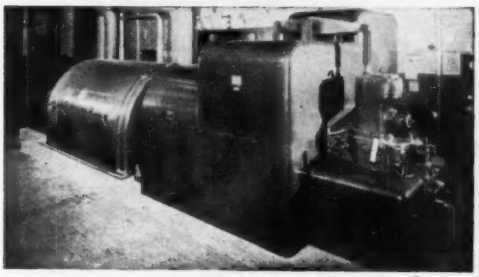
Modern 850lb. 850°—6250 K.V.A. Turbine Generator

80 to 160 lb. Back Pressure

Immediately

Available

Excellent Condition



Actual Photograph

Generator

3/60/2400, 80% P.F.

Built by Westinghouse

Other turbine Generators

1-2000 KW GE	600# 750° Non-Cond. 150# BP 4160/6600V
1-3000 KW Westinghouse	600# 700° Non-Cond. 50/125# BP 2400V
1-3000 KW Westinghouse	400# 750° Cond. 6600/4160V
1-2500 KW Westinghouse	125# Non-Cond. 10# BP 2300V
1-6000 KW GE	200# Condensing 2300V
1-7500 KW Allis-Chalmers	850# 850° Non-Cond. 110# BP.

Cable Address: CHASWEAVER

CHARLES WEAVER, INC.

19701 JAMES COUZENS HIGHWAY

DETROIT 35, MICHIGAN

Telephone: BRoadway 3-1900

Circle 519 on Reader Service Card

FOR SALE

1—2000 KW G.E. Turbine-Generator 400#—750° F Throttle, Automatic 150# and 85# Extraction, 10# Exhaust.

Generator is 2500 KVA, 3-60-480 volt, with exciter and accessories.

WANTED

2500-5000 KW Turbine-Generators 400-600# Throttle, 700-750° condensing or non-condensing.

Write to: Joliet Equipment Corporation
Box 1078, Gross Street, Joliet, Ill.
Or Phone: Joliet SA 7-4738
Chicago BI 2-2458

Circle 523 on Reader Service Card

MOTORS • GENERATORS
TRANSFORMERS
NEW • REBUILT

ELECTRIC EQUIPMENT CO.

WORLD'S LARGEST INVENTORY
CALL COLLECT CL 4-9058
P.O. BOX 51 • ROCHESTER 1, N.Y.

Circle 524 on Reader Service Card

"SEARCHLIGHT" Can Help You!

When you want to buy or sell used or surplus new Power equipment and/or accessories, or have other business wants — advertise them in the SEARCHLIGHT SECTION for quick, profitable results!

HIGHLIGHTS

CIRCUIT BREAKERS

1200 Amp West Drawout Breakers Type 345CA, 1500 MVA, 34.5 KV (8)
2000 Amp Al. Ch. Ruptair Drawout Breakers Type AM150C, 150 MVA, 4.16 KV (2)
1600 Amp Al. Ch. Drawout Breakers Type G50A, 50 MVA, 600 Volt (4)
600 Amp Al. Ch. Drawout Breakers Type G25, 25 MVA, 600 Volt (9)

BOILERS

44500#/hr CE 450 PSI @ 750°F NEW
35000#/hr CE 285 PSI @577°F NEW
18000#/hr Keeler CP 160 PSI
620#/hr Cyclotherm 250 PSI

750 KW 250V DC 900RPM MG SET
3/60/2300 V. (2)

TRANSFORMERS

3750 KVA G.E. 33000-2400-3/60
2000 KVA Al. Ch. 33000-2400 3/60 (2)
1250 KVA G.E. 2400/4160Y-240/480 3/60
750 KVA G.E. 4160-480 3/60
500 KVA Al. Ch. 2400-480 3/60

FURNACE TRANSFORMERS

4450 KVA West. 1/25/1100 —80 to 140V (2)
3125 KVA G.E. 1/60/13200—95 to 155V (6)
2500 KVA West. 1/60/11500—95 to 155V (3)
2500 KVA West. 1/25/10000—70 to 140 V
2000 KVA West. 1/60/13200—120V
750 KVA G.E. 1/25/12000—45 to 60V

HEAT & POWER CO. INC.
60 East 42nd St., New York 17, N.Y.
310 Thompson Bldg., Tulsa 3, Okla.

Circle 521 on Reader Service Card

BOILER

Mfg. Biglow Co.—850 Sq. Ft. Heating Surface —350 lbs. max. Pressure. S. T. Johnson Oil Burner. Complete with Accessories. Scotch Type. New 1951.

P. A. HENAULT CO.
26799 W. Eight Mile Rd., Detroit 40, Mich.

Circle 538 on Reader Service Card

DIESEL GENERATOR SETS

(4) NEW 500 KW GM 8-278

Engines — 715 HP — Vee type — 8 cylinder — 8½ x 10½ — air starting — 720 RPM — 2 cycle — heat exchanger cooled. Engines drive 500 KW Allis-Chalmers D.C. generators—120/240 — 2080 amps — 720 RPM — compound wound. Complete with a very generous supply of spare parts. IF YOU NEED D.C. POWER, NOTHING CAN BEAT THIS VALUE. FULLY GUARANTEED.

NOTE:
We can also quote you using the above engine — radiator cooled and with an A.C. generator — either 440/2300 or 4100 — and offer a completely portable unit.

EXCELLENT GENERATORS FOR STANDBY POWER

(1) UNUSED 250 KW UNIT

440/3/60 — 900 RPM Westinghouse generator — driven by a Cooper-Bessemer 8¾ x 11 engine model F.S.6 — Heat exchanger cooled. This is an unused set in prime condition. Will demonstrate. Unit is a slow-speed heavy duty diesel generator.

(4) AS ABOVE, RECONDITIONED
With Switchgear

Send us your inquiries

THE BOSTON METALS CO.
313 E. Baltimore St., Baltimore 2, Md.
ELGIN 5-5050 LEXINGTON 9-1900

Circle 520 on Reader Service Card

NEW—UNUSED—ASSEMBLED

88,000 LBS/HR

235 PSI.

Union Iron Works package type water tube boiler, model MH-T, rated at 88,000 lbs/hr.—235 psig assembled, and delivered new in 1960—never placed in operation—steel encased and capable of being shipped intact aboard RR car without dismantling. IMMEDIATE DELIVERY. Fully equipped.

OTHER BOILERS IN STOCK

50 hp. Mund Scotch Marine package, oil, 125 psi, fully automatic, new, unused (7)
100 hp. Cycloth. package 125 psi., oil, automatic
175 hp. Comb. Engr. package 375 psi., oil, automatic
500 hp. Cleaver Brooks, package, 150 psi., oil automatic
300 hp. Leffel Scotch Marine package, 150 psi., oil, automatic
600 hp. B&W, 200 psi., 3 drum, assembled, unused.
10,000 lbs/hr., B&W, package watertube, 2100 psi, oil, compl. (exc. for testing purposes)
45,000 lbs. B&W, 435 psi., packaged, oil, assembled, unsued, ready to ship
45,000 lbs. C-Engr. 250 psi. 2 drum assembled, ready to ship
60,000 lbs. B&W, 475 psi., oil, packaged, assembled unused, ready to ship
175,000 lbs, C Engr., 950 psi., 2 drum, stoker and oil, superheat, etc. Complete installed new 1954. All 2½" Tubes.

complete listing catalogue sent upon request

HI PRESSURE BOILERS 10-5000 H.P.

USED—NEW—PURCHASED—SOLD—RENTED
Large and Complete Inventory for Domestic and Export

INDECK POWER EQUIPMENT CO.

9750 N. Skokie Blvd.—Chicago (Skokie), Illinois—OR 3-7666

Circle 525 on Reader Service Card

4 UNUSED CONDENSING 1250 KW WESTINGHOUSE TURBO GENERATORS

TURBINE: 540 lbs. and 850°T.T. working pressure. 8050 R.P.M.

GENERATOR: 1250 KW 440/3/60—0.80 power factor. 1200 R.P.M. with direct connected exciter. Steam rate about 12 pounds per KW hour.

UNITS SUITABLE TO PRODUCE 1500 KW WITHOUT ALTERATION.

ALSO AVAILABLE:

We also have available the following equipment for the above units: 3200 sq. ft. condensers—3200 G.P.M. auxiliary circulating pumps and the condensate pumps.

Send us your inquiries

THE BOSTON METALS CO.
313 E. Baltimore St., Baltimore 2, Md.
ELGIN 5-5050 LEXINGTON 9-1900

Circle 526 on Reader Service Card

ELECTRICAL POWER EQUIPMENT

SLIP RING MOTORS

HP	RPM	MAKE	VOLTS	TYPE
2500	257	G.E.	6600	MT-28
1000	1200	Al.-Ch.	4000	ANY
1000	900	Al.-Ch.	2300	ANY
700	720	G.E.	440	I-M
600	1800	G.E.	4160	M-6345
500	1200	G.E.	440	M-6345Z
400	1200	West.	2300	CW
400	720	G.E.	440	MT-573Y
350	1800	Al.-Ch.	2300	ARYW
300	900	G.E.	440	IM-17
300	450	G.E.	440	IM-16
250	600	West.	2300	CW-1000
200	514	West.	2300	CW-950A

MOTOR GENERATOR SETS

KW	MAKE	A.C.V.	D.C.V.
1750	G.E.	4160/2300	250/300
1250	West.	4160/2300	250
1000	West.	4160/2300	250
750	G.E.	4160/2300	250
600	G.E. (3 unit)	2300/440	125/250
500	G.E.	2300	250
400	Al.-Ch.	2300/440	125/250
250	G.E.	2300	250
200	G.E.	2300	250
150	West.	440	250

D. C. MOTORS

HP	RPM	MAKE	VOLTS	TYPE
1500	300	West.	250	TEFV
850	250/500	West.	250	QM
600	250/500	G.E.	600	DBL. ARM.
500	210	G.E.	250	MCF
400	1150	REL.	250	T-1970
400	300/900	G.M. (2)	250	D4D
300	575/1150	West.	250	CB-509
200	700	West.	250	SK-201
150	280/1000	G.E.	250	MCF
150	1150	G.E. (2)	250	RC-37
150	400/530	West.	250	SK-201
100	400/800	G.E.	250	MPC-6
100	575	G.E.	250	CD-147

50 YEARS 1910-1960 SERVICE TO INDUSTRY

Write for current complete stock lists on electrical power equipment you need or send your list of surplus and used equipment for our offer.

Phone CAnal 6-2900

CHICAGO Electric Co.

1320 W. CERMAK ROAD • CHICAGO 8, ILL.

Circle 527 on Reader Service Card

POWER EQUIPMENT

1500 KW, Elliott, Cond. Turbo-Gen. 3/60, 2300 V., 5000/1200 RPM, 250-400 PSIG, 525°-750°TT.
1000 KW, West. Cond. Extr. Turbo-Gen. 3/60, 245/490 V., 3600 RPM, 130-230 PSIG, 386°-500°TT, 10# Ex.
1000 KW, G.E. Non-C. Turbo-Gen. 3/60, 2300 V., 3600 RPM, 400 PSIG, 600°TT, 90-125 PSIG Exh.
625 KW, Wet. Non-C. Turbo-Gen. 3/60, 480 V., 3600 RPM, 200 PSIG, 5-12 PSIG Exh.
1000 KW, G.M. 16-278A, Diesel Units (2) 3 ph. 60 cycle, 2300 V., 720 RPM
300 KW, G.M. 8-268A, Diesel Units (2) 3 ph. 60 cycle, 480 V., 1200 RPM.

BREW, WOLTMAN

& COMPANY, INC.
50 CHURCH ST., N.Y. 7, N.Y.

Circle 528 on Reader Service Card

BOILERS

1—125 H.P. 300# w.p. with 30" x 28' stack with extra 30" x 9' stack with 4 No. 14 Vertical Bi-Mix Burners John Zink Company, manufactured by Lucey Boiler Manufacturing Company.

3—125 H.P. 250# w.p. without Super Heaters, manufactured by Oilwell Supply Company.

These Boilers are Locomotive Type and in good condition. All inspected and approved by the Texas State Boiler Inspector 1960.

Priced attractively for prompt shipment Bishop, Texas.

MID-STATE PIPE & SUPPLY CO.
703 Philtower Bldg. LUther 2-9128
Tulsa 3, Oklahoma

Circle 529 on Reader Service Card

B O I L E R S

TURBO-GENERATORS • DIESELS
PUMPS • FANS • BURNERS • HEATERS

Large Selection . . . New and Used

EXPERIENCED ENGINEERS TO ASSIST YOU

WABASH POWER •EXPORT•

WABASH

POWER EQUIPMENT CO.
Phone: IN. 3-0303
3300 W. Patterson Ave.
Chicago 45, Ill.

Circle 530 on Reader Service Card

75 TON BRIDGE CRANE

1—75 Ton capacity Whiting Mfg. Co. bridge crane with auxiliary hoist, 51 ft. span, complete with operating motors, control and rail.

Excellent condition.

Can be inspected in operation.

UTILITIES MACHINERY CORP.
1965 EAST SIXTH STREET
CLEVELAND 14, OHIO

Circle 531 on Reader Service Card

38 Years Dependable Service

SLIP RING MOTORS 3 Ph., 60 Cy.

H.P.	Volts	Make	Speed
500	4000/2300	G.E.	600
450	4000/2300	G.E.	1200
400	2300/440	G.E.	600
400	4000/2300	Whse.	720
350	440/220	G.E.	1800
300	4000/2300	G.E.	720
300	440	Whse.	3600
250	4000/2300	Al. Ch.	600
200	2300	G.E.	600
200	2200/440	G.E.	720
150	440/220	G.E.	1800
150	2200/440	Whse.	720
125	2300	G.E.	600

AC GENERATORS or SYN MOTORS, 60 Cy.

H.P.	Volts	Make	Type	R.P.M.
400	2300	G.E.	TS	1800
400	2200/440	G.E.	ATI	720
300	2200/440	G.E.	TS	1200
300	440	G.E.	TS	720
150	440/220	Whse.	G	1200

SQUIRREL CAGE MOTORS

500	2300/4000	G.E.	FT	1200
500	2200/4000	Elliott	SC	1800
400	2300	G.E.	FT	3600
400	2300/4000	G.E.	K	1200
350	2300/4000	G.E.	SEDP	3600
350	2300/4000	G.E.	K	600
300(2)	2300	G.E.	FT	3600
300	2300/4000	L. Allis	FS	1800
300	2300/400	G.E.	KT	600
250	2300/4000	G.E.	K	720
250	2300/440	G.E.	K	1200
200(2)	440	G.E.	Dr-Pf.	720
200	2200	G.E.	KT	1800
200	2200	Cont.	TEFC	3600
150	440	El. Mchy.	Dr-Pf.	900
150	440	Whse.	X-pf.	3600
150	440/220	G.E.	TEFC	720
150	2200/440	G.E.	TEFC	3600
125	2200/440	G.E.	FT	1200
100	440	Whse.	TEFC	3600
100	440	Cont.	X-pf.	1800
100	2200	G.E.	FT	900

CIRCUIT BREAKERS, 3 Pole

2—1600 Amp., G.E., AL-50, 600 V., Air
1—1600 Amp., G.E., AL-50, 600 V., outdoor
1—1200 Amp., Whse., F-124, 7.5 KV, manual
1— 600 Amp., G.E., 15 KV, Sol. oper.
1— 600 Amp., Whse., 7.5 KV, outdoor, New.

D. C. MOTORS

H.P.	Volts	Make	Type	Speed
140	230	G.E.	CD	850
100	230	Rel.	1050T	300/1100
90	230	G.E.	CD	1750

MOTOR GENERATOR SETS

KW	Make	Input., AC	Motor Type	Output V., DC
300	Whse.	4150/400	Syn.	250/125
150	G.E.	440/220	Syn.	250
125	G.E.	440/220	Sq. Ca.	125
100	G.E.	2200/440	Syn.	230
65	G.E. B	2200/440	Sq. Ca.	250

TRANSFORMERS 60 Cy.

3—500 kva, G.E., 13,800—240/480 V.
3—200 kva, Mol., 13,800—2300 V.
3—333 kva, G.E., 13,800—2400 Y.
3—333 kva, G.E., 2400—240/120 V.
3—333 kva, Whse., 2400/4160Y—240/480 V.
1—300 kva, Whse., 4160—480 V., Dry, New
3—250 kva, Whse., 2400/4160Y—240/480 V.
3—240 kva, G.E., 460—230 V., 3 ph. Dry
3—200 kva, G.E., 2400—460V. Pyr.
3—200 kva, G.E., 13,800—480 V.
3—167 kva, Whse., 4156—480 V.
3—150 kva, Al. Ch., 2400—220 V.
3—150 kva, G.E., 13,200—2300 Y.
1—150 kva, Whse., 4160—120/208Y V., 3 ph. Dry
3—150 kva, G.E., 460—230 V., 3 ph. Dry
3—100 kva, Whse., 2400—240/480 V., Dry
3—100 kva, G.E. 2400—120/240 V., Pyr.

only partial listing

STEPHEN HALL & CO.
HARRY J. RICE, Pres.
625 ADAMS ST., HOBOKEN 2, N. J.

Circle 533 on Reader Service Card

TRANSFORMERS

BOUGHT · SOLD · RENTED
REWOUND · RE-DESIGNED
MANUFACTURED

Ask for our Stock List

For Sale

3—2500 KVA G-E 69000—2400/4160Y
3—2500 KVA G-E 69000—7200/12470Y
4—2500 KVA W-H 34500—2400/4800/11000
3—1500 KVA G-E 69000—2400/4160Y
3—1500 KVA G-E 69000—7200/12470Y
3—1000 KVA G-E 34500—7200/12470Y
3— 833 KVA W-H 43800—480
3— 667 KVA G-E 13200—2400/4160Y

THE ELECTRIC SERVICE CO., 5322 Hetzel St., Cincinnati 27, Ohio
"America's Exclusive Independent Transformer Service Shop"

Circle 534 on Reader Service Card

BOILERS

From the unfinished Battle Cruiser "Hawaii"

Material installed completely and never used.

7 Babcock & Wilcox Watertube Boilers

Approximately 157,000 lbs/hour. Working pressure 600#—850° T.T.—Oil-fired—with all boiler trim. Units are complete with fuel oil burning equipment—feed water pumps—feed water heaters, etc. Units are in prime condition.

CAN BE LOADED AS A UNIT OR DISMANTLED AND SHIPPED IN SMALLER SECTIONS

THE BOSTON METALS CO.
313 E. Baltimore St., Baltimore 2, Md.
ELGIN 5-5050 — LEXINGTON 9-1900

Circle 535 on Reader Service Card

BABCOCK & WILCOX COAL PULVERIZERS

2—NEW UNUSED Babcock & Wilcox coal pulverizers, Type E-56, each equipped with American Blower Corporation air fan, 15,000 cfm capacity with motor drive. These are complete coal pulverizer installations with blower air fans, attached and unattached structural parts, capacity 20,000# coal per hour each pulverizer. Exceptional bargain.

UTILITIES MACHINERY CORPORATION
1965 East Sixth Street, Cleveland 14, O.

Circle 536 on Reader Service Card

3—Wagner 500 KVA transformers, 66,000—460 V.
1—G.E. 1500 KVA unit substation, 13200—480 V.
3—Worthington 3500 CFM air compressors, 24x15, #LTC-4, 500 HP gas drive.
1—Chicago-Pneu. 3060 CFM air comp., #19-32-30-18x24, 60 PSI, steam drive.
3—G.E. 1000 KVA transformers, 1Ø, 13800-V.
2—200 HP water-tube boilers, 160 PSI.
1—Gardner-Denver air comp., 445 CPM

PERRY EQUIP. CORP.
1422 N. Sixth St.
Philadelphia 22, Pa.
POplar 3-3505

Circle 537 on Reader Service Card

RE-NU-BILT ELECTRICAL EQUIPMENT

53 YEARS SERVICE

MOTOR GENERATOR SETS

Qu.	KW	MAKE	RPM	AC VOLTS	DC VOLTS
2	4800	G.E.	450	2300/4600	250/300
1	2500	WHSE.	720	2300/4160	600
1	2100/2400	G.E.	450	2300/4600	250/300
2	1750/2100	G.E.	514	2300/4600	250/300
1	2000	G.E.	514	2300/4600	600/666
1	1500	G.E.	720	13200/6600	600
1	1250	WHSE.	720	2300/4000	600
1	1000	G.E.	900	2300/4000	600
1	1000	G.E.	900	6600/4000	260
1	1000	G.E.	720	2300/4000	275
1	500	G.E.	900	2300/4600	250
1	500	G.E.	900	440	250/125
2	300	G.E.	1200	2300	275
1	300	WHSE.	1200	2300/4100	600
1	200	G.E.	1200	2300/4160	250
1	125	G.E.	1200	440	250

FREQUENCY CHANGER SETS

Qu.	KW	MAKE	FREQ.	VOLTAGES
1	12500	WHSE.	60 To 25	13200-13200
1	5000	G.E.	60/50/60	11000-6600
1	2500	G.E.	60/24/60	2400-2400

3 PHASE 60 CYCLE MOTORS SLIP RING

Qu.	HP	MAKE	TYPE	VOLTS	SPEED
1	1750	G.E.	M-570BS	4800/2400	1800
1	800	WHSE.	CW	550/2200	1776
1	600	WHSE.	CW-32D	440	1778
1	600	WHSE.	CW	440	850
1	550	WHSE.	CW	440	252
1	500	WHSE.	CW	2300	881
1	500	WHSE.	CW	550/2300	350
1	300	AL. CH.	ANY	2200	720
1	300	GEN. EL.	MTP-561	2200	1760

SQUIRREL CAGE

Qu.	HP	MAKE	TYPE	VOLTS	SPEED
3	1500	G.E.	K.D.P.	2300	3580
1	1000	AL. CH.	ANW	2300	1180
1	550/275	WHSE.	CS-1115	2300	863/445
2	500	WHSE.	CSP-583H D.P.	440	3600
4	500	AL. CH.	ARW-D.P.	2300	3600
2	450	EL.	FR3910	2200	1185
1	400	WHSE.	CS7151	6600	3565

OUTDOOR
G.E. METAL CLAD SWITCHGEAR
600 V. 3 POLE, A.C.B.

1—3000 AMP., AL-2-75, ELEC. OPER
1—1000 AMP. AL-2-50, MANUAL
4— 800 AMP, AL-2-50 MANUAL
1— 400 AMP., AL-2-50 MANUAL
3—SPARE COMPARTMENTS

PUMPS — MOTOR DRIVEN

4—600 G.P.M. Gould, Figure 3360, 8 Stage, 2310 Ft. Head, 1000#, 3550 RPM, Each coupled to 500 HP 3-60-3350 RPM D.P. Sq. Cage Motor

2—WHSE, Type CSP-583H, 440 volt

2—Allis Type 2300 volt Magnetic Encl. Reduced Voltage Starters

BELYEA COMPANY, INC.
43 Howell St., Jersey City 6, N. J.
Phone: OL 3-3334—N.Y.C. RE 2-7150

Circle 532 on Reader Service Card

Advertisers' Index

A

Air Preheater Corp. ..... *
Air Reduction Sales Co. 35
Allegheny Ludlum Steel Corp. ..... *
Allgemeine Elektricitats-Gesellschaft ..... Second Cover
Allis-Chalmers Mfg. Co. 24-25
Allpax Company, Inc. 106
American Gilsonite Co. 151
American Oil Company ..... *
American Pulverizer Co. 158
Anaconda American Brass Co. ..... *
Anchor Packing Co. 113
Anderson Co., V. D. ..... *
Aquamatic, Inc. 166
Armstrong Cork Co. 165
Armstrong Machine Works 137
Associated Elec. Industries Export Ltd. .. 28
Atomics International A Div. of North American Aviation, Inc. *
Aurora Pump Div. New York Air Brake Co. 128

B

B-I-F Industries ..... *
Babbitt Steam Specialty Co. 126
Babcock & Wilcox Co. Boiler Div. ..... *
Babcock & Wilcox Co. Refractories Div. ..... *
Babcock & Wilcox Co. Tubular Products Div. 30
Babcock & Wilcox Co. Tubular Products Fittings Dept. ..... *
Badger Mfg. Co. ..... *
Bailey Meter Co. 4-5
Barco Manufacturing Co. 168
Barnes & Jones, Inc. 132
Bell & Gossett Co. 59
Belmont Packing & Rubber Co. ..... *
Biddle Co., James G. ..... *
Black, Sivalls & Bryson, Inc. ..... *
Boiler Engrg & Supply ..... *
Boiler Tube Co. of America ..... *
Borg-Warner Mechanical Seals ..... *
Bridgeport Brass Co. 167
Brown Boveri Corp. 120
Buell Engineering Co. 206
Buffalo Forge Co. 42
Bussmann Mfg. Div. McGraw-Edison Co. 64-65
Butler Manufacturing Co. ..... *
Byron Jackson Pumps Inc. Subsidiary of Borg Warner Corp. ..... *

C

Carling Turbine Blower Co. 150
Carpenter Steel Co. ..... *
Catawissa Valve & Fittings Co. ..... *
Chesterton Co., A. W. 110
Chicago Pneumatic Tool Co. ..... *
Clarage Fan Co. 52
Clark Bros. One of the Dresser Industries 39
Clayton Manufacturing Co. ..... *
Cleaver-Brooks Company ..... *
Cochrane Division Crane Company ..... *
Combustion Engineering, Inc. 40-41
Cooper-Bessemer Corp. ..... *
Copes-Vulcan Div. Blaw-Knox Company 8-9
Coppus Engineering Corp. 127
Corning Glass Works ..... *
Crane Company 129
Crawford Fitting Co. 43
Croll-Reynolds Engineering Co. ..... *

D

Darling Valve & Mfg. Co. 142
Dearborn Chemical Co. ..... *
De Laval Steam Turbine Co. ..... *
Detroit Stoker Company 37
DeVar Systems Inc. Div. of General Kinetics, Inc. ..... *
DeVilbiss Company 60
Diamond Power Specialty Corp. 6-7
Dodge Manufacturing Corp. ..... *
Dow Chemical Co. 171
Dow Corning Corp. ..... *
Dow Industrial Service Div. of Dow Chemical Co. ..... *
DuPont De Nemours & Co., E. I. Industrial & Biochemicals Dept. 159
DuPont De Nemours & Co., E. I. Polychemicals — Teflon 99

E

Eagle-Picher Company 48
Eastern Gas & Fuel Associates ..... *
Edison Industries, Thomas A. Instrument Div. ..... *
Edward Valves, Inc. 12-13
Electric Machinery Mfg. Co. ..... *
Electric Storage Battery Co. 143
Elektrim 154
Elgin Softener Corp. ..... *
Elliott Company 46, 130
Elliott Company — Lagonda Plant ..... *
Elliott Company — Roto Plant ..... *
Engineer Company ..... *
Everlasting Valve Co. 44

F

Fairbanks, Morse & Co. ..... *
Field Control Div. Conco Engrg Works, Inc. ..... *
Fisher Governor Co. 119
Flexitallic Gasket Co. ..... *
Flexonics Div. of Calumet & Hecla, Inc. ..... *
Fluor Products Co. ..... *
Foster Co., Benjamin 131
Foster Wheeler Corp. 115
Foxboro Company 54
Fuller Company ..... *

G

Gardner-Denver Co. 153
Garlock Incorporated 136
General Controls ..... *
General Electric Co. 53, 104, 105
General Precision, Inc. Kearfott Division 134
Goulds Pumps, Inc. 157
Grinnell Company 36
Griscom-Russell/C. H. Wheeler 66
Gustin-Bacon Mfg. Co. ..... *

H

Hamon, Inc. ..... *
Hitachi, Ltd. 116
Hoffman Specialty Mfg. Corp. ..... *
Hungerford & Terry, Inc. 126

I

Illinois Water Treatment Co. ..... *
Industrial Combustion, Inc. 162
Industrial Instruments, Inc. ..... *
Ingersoll-Rand 111
International Nickel Co., Inc. Huntington Alloy Products Div. 118
International Salt Co. ..... *
Iron Fireman Mfg. Co. ..... *

J

Jenkins Bros. 101
Johns-Manville 22-23, 176
Johnson Service Co. 32
Joy Manufacturing Co. 18-19

K

Keasbey & Mattison Co. 1
Keeler Co., E. ..... *
Kerrigan Iron Works Co. 152
Kieley & Mueller, Inc. ..... *
Koppers Co., Inc. Couplings Dept. ..... *
Koppers Co., Inc. Electrostatic Precipitators 33
Kuljian Corp. 112

L

Leslie Company ..... *
Limitorque Corp. 149
Link-Belt Company ..... *
Liquidometer Corp. ..... *
Lunkenheimer Company ..... *

M

Madden Corp. ..... *
Magnatrol Valve Corp. ..... *
Manning, Maxwell & Moore, Inc. 16
Marley Company 135
Marsh Instrument Company Div. of Colorado Oil & Gas Corp. ..... *
Mason-Neilan Div. of Worthington Corp. ..... *
McDonnell & Miller, Inc. 156
McGraw-Hill Book Co. 166
Meaker Company Sub. of Sel-Rex Corp. ..... *
Mercoid Corp. ..... *
Metropolitan Refining Co. 174
Midwest Piping a Div. of Crane Co. 45
Minneapolis-Honeywell 61
Morton Salt Co. Industrial Div. 17
Murray Mfg. Co., D. J. 170

N

Nalco Chemical Co. 29
National Tube Div. of U. S. Steel 145
Niagara Blower Co. ..... *
Nicholson & Co., W. H. 114
Nordberg Manufacturing Co. ..... *
Norfolk & Western Railway 14-15
North American Mogul Products Co. 55
Norwalk Company, Inc. ..... *
Novenco Inc. ..... *

This index is a service to readers. Every effort is made to maintain its accuracy, but POWER cannot assume responsibility for errors or omissions. When a star appears after the name, the advertisement does not appear in this issue but appeared in an issue within the previous three months.

O

OPW-Jordan Corp. 154
Ohio Injector Co. 31
Onan Division
Studebaker-Packard Corp. 20-21
Orr & Sembower, Inc. ..... *

P

Patterson-Kelley Co. ..... *
Peerless Pump, Hydrodynamics Div.
Food Machy. & Chemical Corp. 175
Penberthy Mfg. Co. ..... *
Pennsylvania Crusher Div.
Bath Iron Works Corp. 117
Pennsylvania Flexible Metallic Tubing Co. 150
Pfaudler Permutit, Inc. ..... *
Pfizer & Co., Inc., Charles
Chemical Sales Div. ..... *
Phelps Dodge Copper Products Corp. ..... *
Philadelphia Gear Corp. 149
Pipe Fabrication Institute 154, 155
Pittsburgh Plate Glass Co.
Fiber Glass Div. ..... *
Plibrico Company ..... *
Powell Co., Wm. 62
Power Regulator Co. ..... *

R

R-P & C Valve Div.
Amer. Chain & Cable Co., Inc. 50
Raybestos-Manhattan, Inc.
Manhattan Rubber Div. ..... *
Raybestos-Manhattan, Inc.
Packing Div. ..... *
Reliance Gauge Column Co. ..... *
Republic Flow Meters Co. 124, 125
Republic Steel Corp. ..... *
Research-Cottrell, Inc. ..... *
Revere Copper & Brass, Inc. 10-11
Ric-Wil Incorporated 58
Ridge Tool Company 47
Riley Stoker Corporation 96-97
Robvon Backing Ring Co. 173
Rohm & Haas Co. 34

S

Sarco Company, Inc. 38
Scam Instrument Corp. ..... *
Schaub Engineering Co., Fred H. 144
Scovill Mfg. Co. 141
Shell Oil Co. 163
Smith Corp., A. O. ..... *
Spence Engineering Co. ..... *
Squires Co., C. E. ..... *
Stearns-Roger Mfg. Co. ..... *
Stephens-Adamson Mfg. Co. 56
Stickle Steam Specialties Co. ..... *
Stock Equipment Co. ..... *
Superior Combustion Industries, Inc. 109

T

Tennant Development Corp. 126
Terry Steam Turbine Co. 169
Thermo Electric Co., Inc. ..... *
Titusville Iron Works Co.
Div. of Struthers-Wells Corp. ..... *

U

Union Iron Works 147
U. S. Electrical Motors, Inc. ..... Third Cover
United States Motors Corp. ..... *
Universal Atlas Cement
Div. of U. S. Steel ..... *

V

Valley Camp Coal Co. 51
Viking Pump Co. ..... *
Vogt Machine Co., Henry 57

W

Wallace & Tiernan, Inc. 164
Wallingford Steel Co. ..... *
Walworth Company ..... *
Weir Chicago Bridge, Inc. ..... *
Western Chemical Co. 146
Western Precipitation ..... *
Westinghouse Electric Corp. ..... *
Wheeler, C. H. 66
Whitey Research Tool Co. ..... *
Wickes Boiler Co. 133
Wiedeke Co., Gustav ..... *
Williams Gauge Co. 152
Wolverine Tube
Div. of Calumet & Hecla, Inc. ..... *
Worthington Corp. ..... Back Cover
Wright-Austin Co. 172

Y

Yarnall-Waring Company 26-27, 49
York Corporation
Subsidiary of Borg-Warner Corp. ..... *
Yuba Consolidated Industries, Inc. ..... *

Z

Zallea Brothers 121

Professional Services 197

CLASSIFIED ADVERTISING

F. J. Eberle, Business Mgr.

EMPLOYMENT OPPORTUNITIES ... 197-198

EQUIPMENT
(Used or Surplus New)
For Sale 197-203

WANTED
Equipment 199

ADVERTISERS' INDEX

Allied Electric Co. 199
American Air Compressor Corp. 198

Baker Commodities Inc. 199
Beeson Engineering Co., Frank M. 200
Belyea Co., Inc. 203
Boston Metals Co. 109, 201
Brew, Wolman & Co., Inc. 202
Bury Compressor Corp. 200

Chicago Electric 202
Combustion Engineering Inc. 197
Crook Inc., F. S. 198

Drew Co., Inc., E. F. 198

Ebasco Services Incorporated 199
Electric Equipment Co. 201
Electric Service Co. 203

Hall & Co., Stephen 203
Heat & Power Co., Inc. 199, 201
Hemphill & Co., J. L. 200
Henault Co., Philip A. 201
Hotel Del Coronado 199

Indeck Power Equipment Co. 202

Joliet Equipment Corp. 201

Luria Brothers 198

Machinery Center Inc. 200
Mid-States Pipe and Supply Co. 202
Midwest Boiler & Turbine Co. 200

O'Brien Machinery Co. 200

Pelnik-Loconti Industrial Supply Co. 200
Perry Equipment Corp. 198, 203

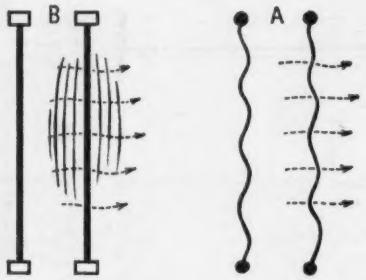
Soul Clinic 198

Universal Power Engineering Co. 200
Utilities Machinery Corp. 202, 203

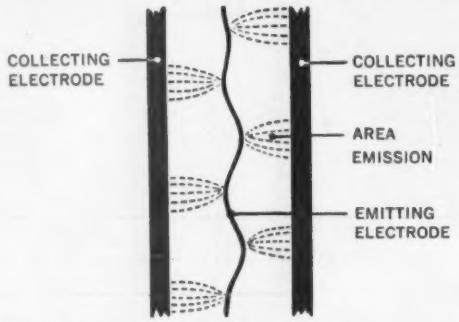
Wabash Power Equipment Co. 202
Wagner Company, Arthur 199
Weaver Inc, Charles 201

SUPERIOR PRECIPITATOR PERFORMANCE

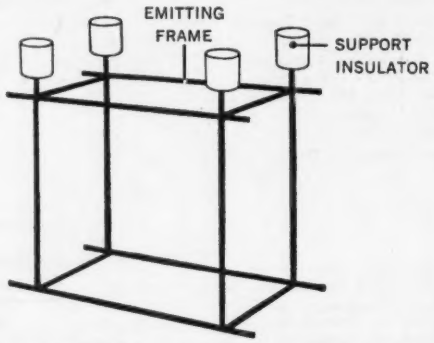
—how it's helped by Buell's exclusive emitting system



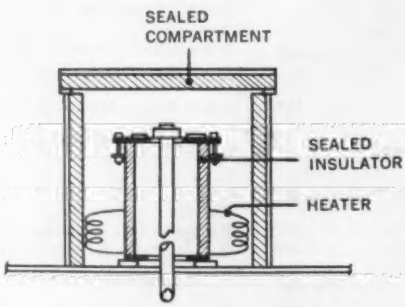
LESS THAN 2% REPLACEMENT — Each stainless steel Buell Spiralectrode is firmly fixed top and bottom to a rigid frame (A). Self-tensioned in this way, the electrode does not sway or lose alignment as shown at (B), even under current surges or varying gas flows. Buell's 10-year replacement record in this critical area is under 2%.



HIGHEST EMISSION—TOP EFFICIENCY — The patented spiral shape of emitting electrodes in the Buell precipitator presents collectors with areas of maximum emission per unit of power input. Because there is no problem of efficiency-destroying misalignment here, you can apply maximum voltage to achieve peak emission.



RUGGED SUSPENSION — Buell SF Electric Precipitators are designed and built to take extremely rugged operating conditions. The emitting frame is constructed of heavy-gauge steel and the whole unit is held rigid by four supporting insulators. Because of this rigid box-type construction, misalignment or arcing is not a problem.



QUARTZ INSULATORS — SEALED COMPARTMENTS — Special temperature- and shock-resistant quartz insulators are sealed in individual compartments. This prevents circulation of dirty gas from the precipitator, without the need for costly ventilating systems. Thermostatically controlled heaters prevent condensation during start-up.

. . . and don't forget the simple, effective, mechanical rapping system, possible only because rugged Buell construction permits electrodes to be so rigidly mounted. Other features: Buell's advanced collecting electrode design . . . adjustable baffles. No wonder you're sure to be pleased with Buell's superior performance, minimum maintenance! **Buell Engineering Co., Inc., Department G, 123 William Street, New York 38, New York.** Electric Precipitators · Cyclones · Bag Collectors · Combination Systems · Classifiers · Fans. Member Industrial Gas Cleaning Institute

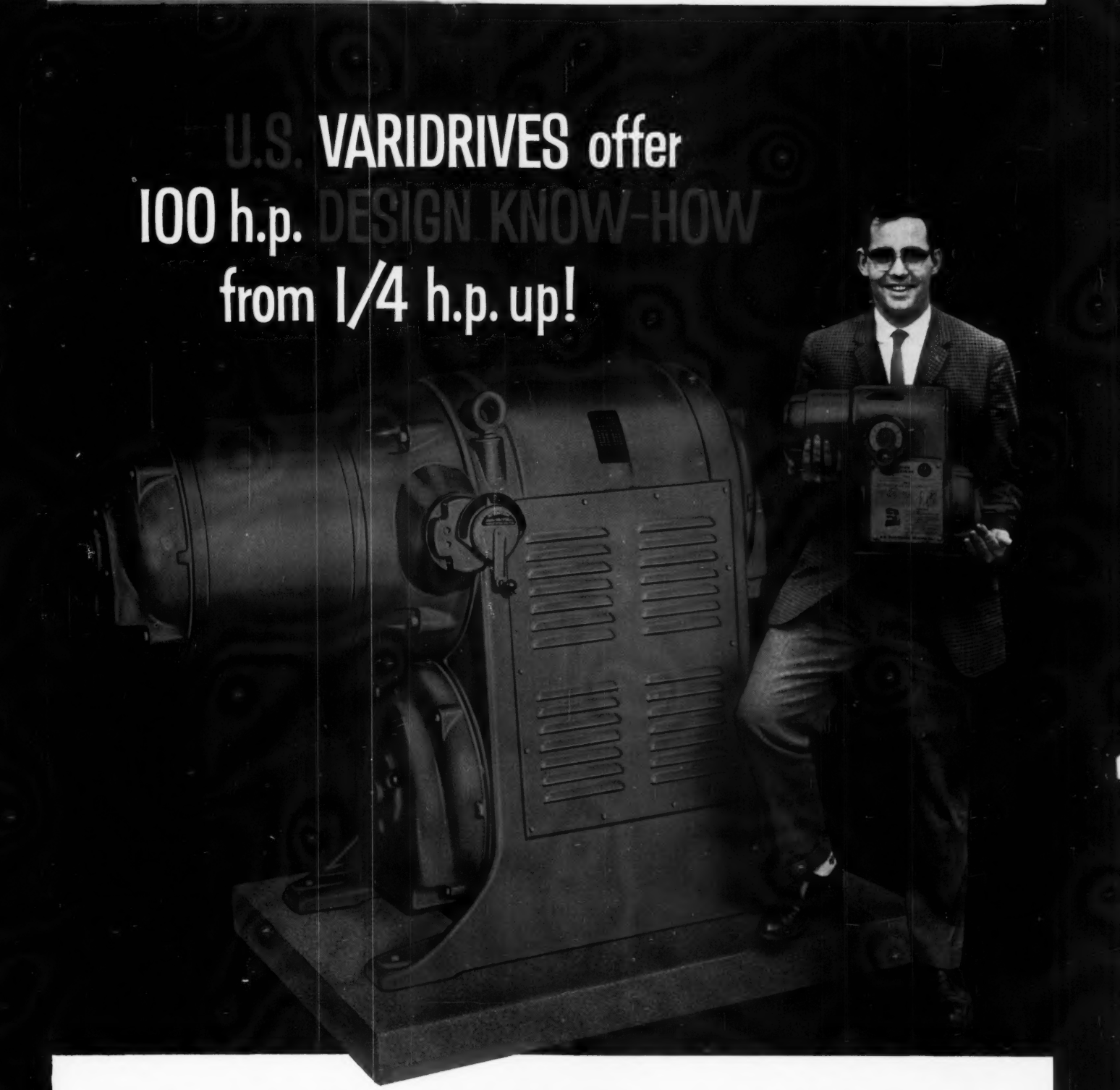
buell Norblo

For more facts circle 326 on Reader Service card, p 107

Circle 202 on Reader Service card for U.S. Elec. Motors Ad ➤

Circle 203 on Reader Service card for Worthington Ad ➤

U.S. VARIDRIVES offer 100 h.p. DESIGN KNOW-HOW from 1/4 h.p. up!

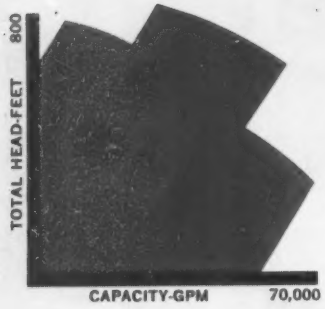


NOW we offer 100 h.p. U.S. VARIDRIVE MOTORS, another link in the long chain of design developments pioneered by U.S. Motors. From the time we offered the first VARIDRIVES 29 years ago, right on up the line to today's 100 h.p. model, U.S. design ability has kept VARIDRIVES years ahead. With U.S. VARIDRIVES you are not limited to 40 h.p. As long as 12 years ago U.S. Motors offered its 50 h.p. model—then 60, 75 h.p.—and now 100 h.p. This leadership in design ability serves you, whatever VARIDRIVE you select, with special U.S. benefit features from the ¼ h.p. model up!

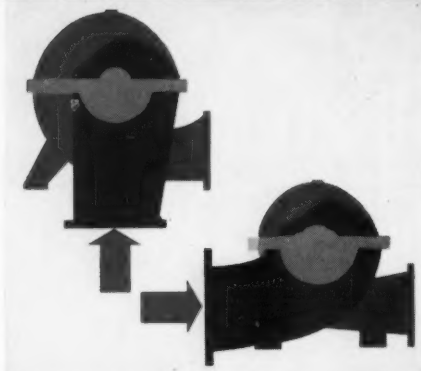
U.S. ELECTRICAL MOTORS INC.

Los Angeles 54 (P. O. Box 2058) California—or Milford, Connecticut

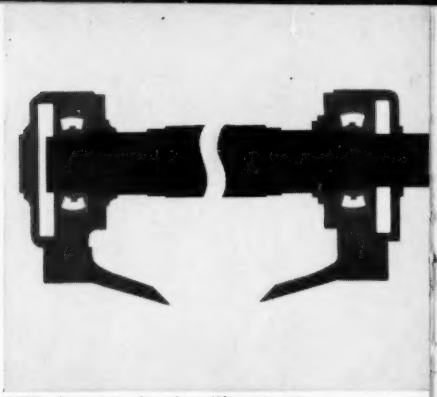
FREE COLOR BROCHURE ... send for Varidrive Bulletin No. F-1797



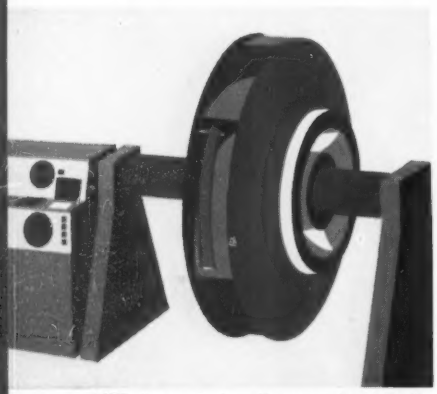
PERFORMANCE. Broad coverage gives precise selection for highest efficiency.



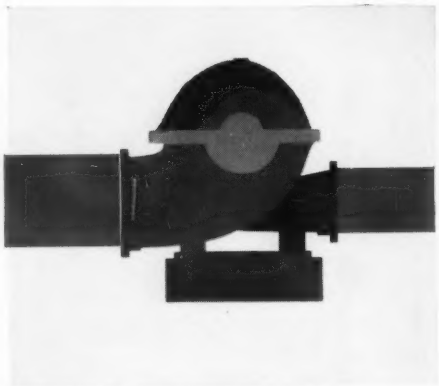
PERFORMANCE. Best because side or bottom suction matches installation best.



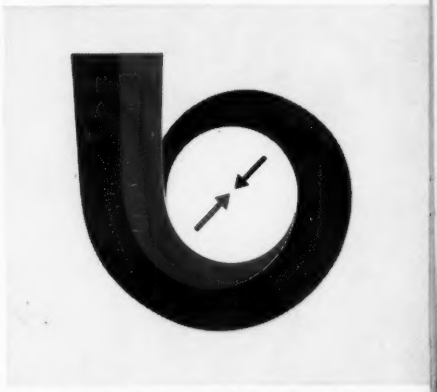
LIFE. Longest—bearing life actually exceeds any known specification requirement.



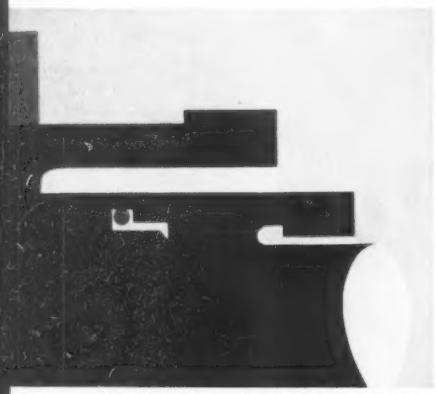
LIFE. Longest—impellers are dynamically balanced to cut bearing and packing wear.



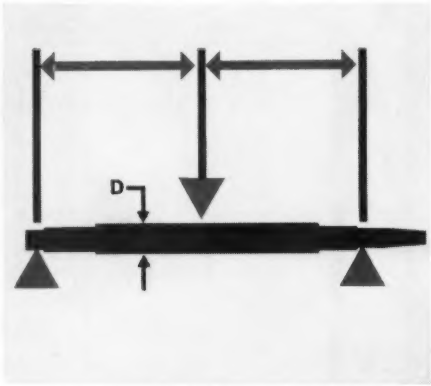
MOST ECONOMICAL. Space and piping required smaller than comparable pumps.



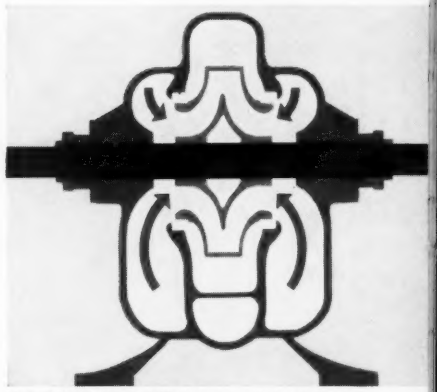
LIFE. Longest because double volute designs are used for better radial balance.



LIFE. Longest—exclusive "O" ring arrangement gives best erosion protection.



LIFE. Longest—shaft diameters and bearing spacing provide minimum deflections.



PERFORMANCE. Efficiency sustained best because of truly functional design.

For general service . . .

NINE FEATURES—UNIQUE PUMP VALUE

Look at these nine features! Taken together, they are a unique group—no other general service pump made has them all. Along with other important features, they give this LN pump the most value at a very competitive price.

LN pumps have been engineered to take full advantage of double volute construction. It's the most complete line of double volute pumps made. The double volute, of course, extends operating range from design point to shut-off without harmful effects from excessive deflection. Similarly, pump life is longer because the bearing brackets are cast and machined with the casing to give perfect alignment.

And here's another advantage. The line is widely adaptable—all-iron fitted, all-bronze, or stainless trim are available. Not to mention suction vents, vertical mounting, oil-lubricated ball bearings and other modifications you may desire.

Most important, however, we believe that no other pump on the market can equal the low cost of installing, operating and maintaining LN pumps. Frankly, we'd like to quote the LN line for you, so you see its total value in a competitive light.

Please contact your nearest Worthington District Office, or write Worthington Corporation, Dept. 21-6, Harrison, New Jersey. In Canada, Worthington (Canada) Ltd., Brantford, Ontario.

WORTHINGTON

PRODUCTS THAT WORK FOR YOUR PROFIT